MACHINERY.

June, 1908.

THE WESTINGHOUSE DOUBLE-FLOW STEAM TURBINE.

DETAILS OF RECENT DEVELOPMENTS IN THE PARSONS TYPE.

AN interesting example of the greatly increased power capacity per unit of floor area, made possible by the use of steam turbines in place of reciprocating engines, is found in the Brunot Island station of the Pittsburg Railways Co. This station is one of the scores of street railway power stations in which it has been found necessary to increase the capacity far beyond the original plans, in response to the extraordinary growth of urban and interurban transportation lines. In this station, space had been provided for three additional 1,500 K.W. cross-compound condensing engines, but the demand for power made it imperative to immediately provide much more than the original plans had called for. An installation of Westinghouse double-flow turbine has been placed in the space originally assigned to the three reciprocating engines, and instead of gaining only 4,500 K.W., 18,000 K.W. has been added in the shape of one 3,000 K.W. and three 5,000 K.W. double-flow units, with space still remaining for another 5,000 K.W. unit. When this unit is placed there will be 23,000 K.W. developed, or *fifteen times* the power of the original lay-out in the same space.

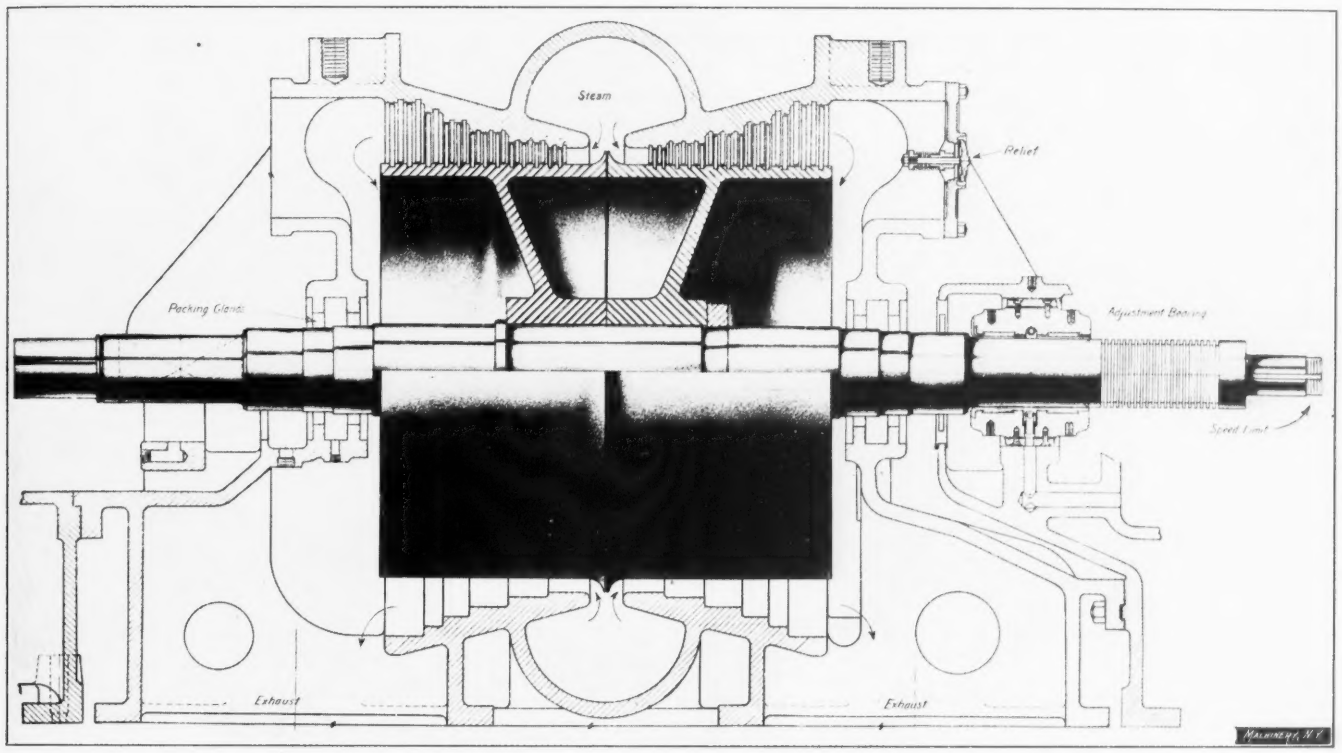


Fig. 1. The Westinghouse Low-pressure, Double-flow Steam Turbine.

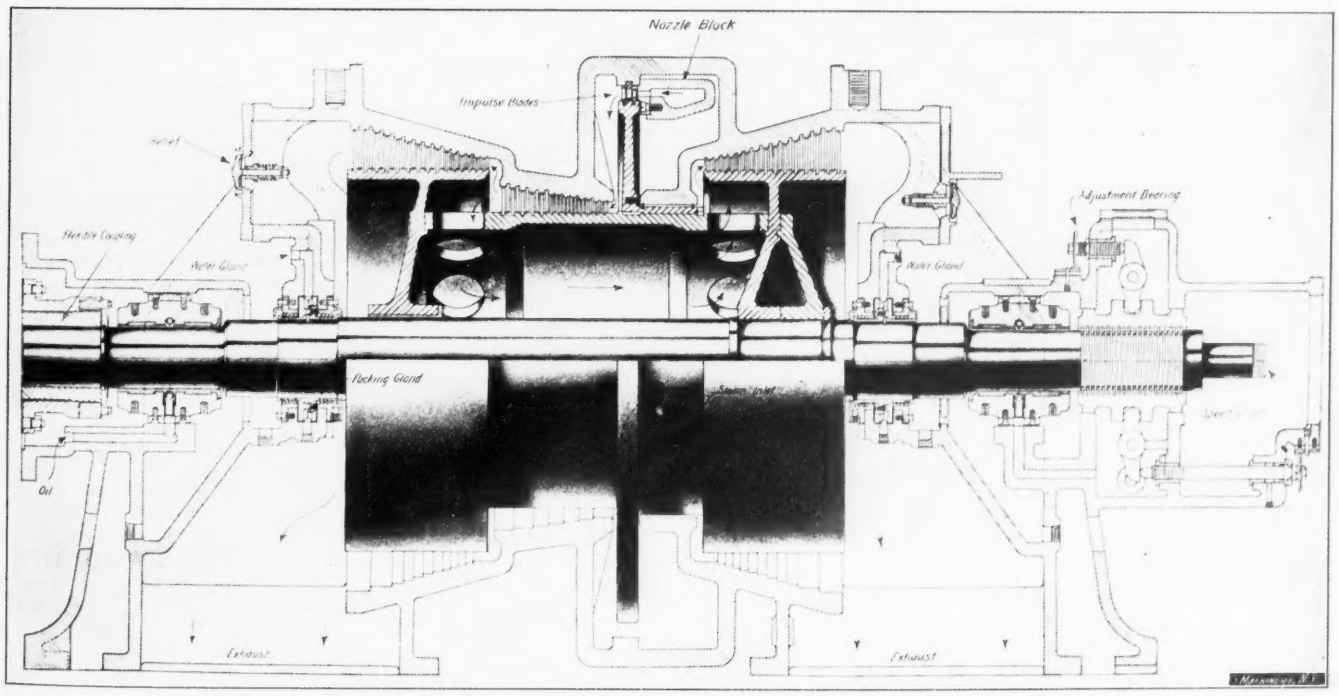


Fig. 2. The Westinghouse High-pressure, Double-flow Steam Turbine.

The following description deals with the development of the double-flow Westinghouse turbine in considerable detail, inas-

much as this turbine has not been described to any extent in the American technical press. The double-flow principle as embodied in these large machines is a development brought about entirely by considerations of mechanical construction. It is not by any means without precedent—in fact, the original Parson's turbine, constructed in 1880, was of the simple double-flow type—and in hydraulic work the double-flow principle is largely used to produce a rotor running in perfect axial equilibrium. In small machines, however, the advantages of the double-flow principle are not as preeminent as in the large, principally because of the absence of the necessity therefor from a mechanical standpoint, and by reason of the fact that the economy of two small machines is not likely to

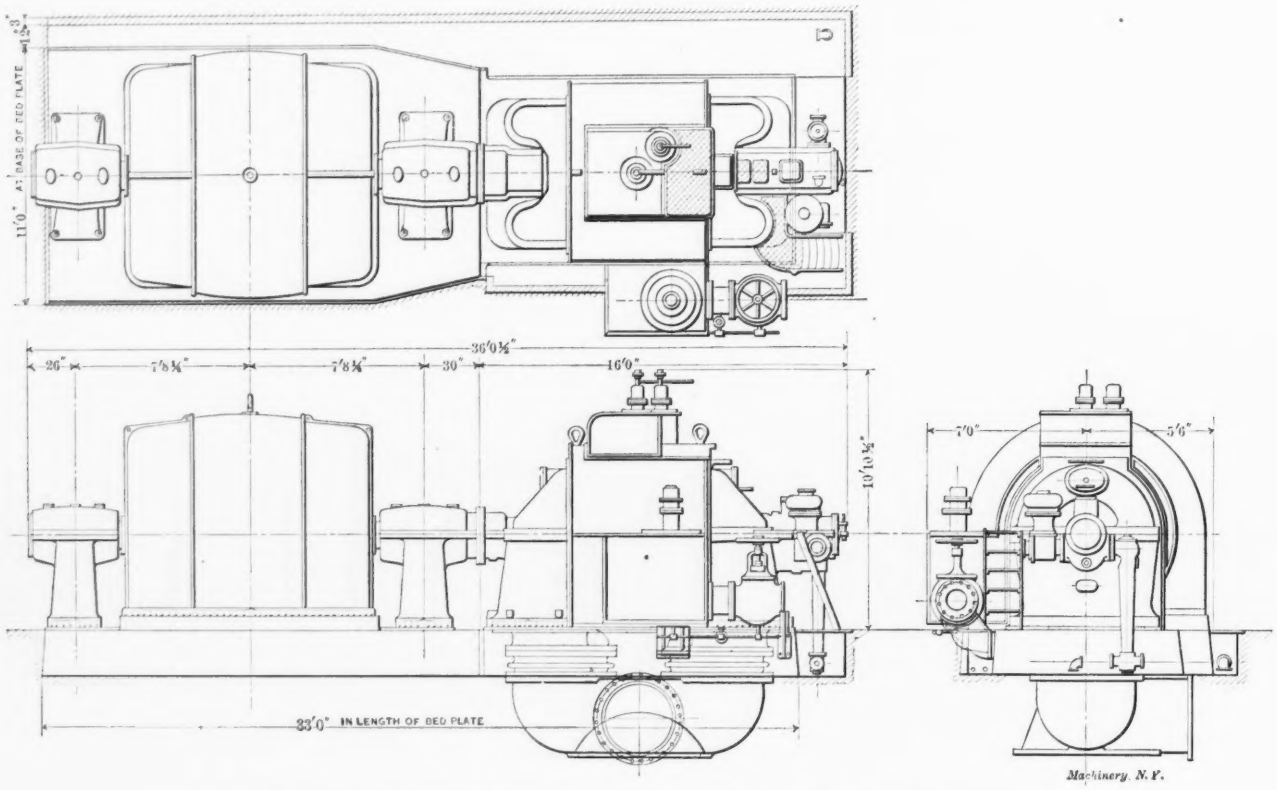


Fig. 3. Plan and Elevation of the Westinghouse 5000 K. W. Double-flow Steam Turbine.

be as good as one of twice the capacity. In turbines of very large size, however, where proportions exist more favorable to the attainment of high economy, the latter advantage does not obtain.

The double-flow turbine may thus be regarded as the result of an insistent demand for turbine-generating units of great capacity at high speeds. The 5,500 K.W. unit installed several years ago alongside the huge Corliss units at the Manhattan elevated station, New York City, proved to be only the beginning, and to-day 10,000 K.W. units have been built, while even larger ones are contemplated. For these large machines, the advantages of the combined impulse and reaction principle of steam expansion, together with the double-flow construction, are so important that the practical result, as embodied in the machine under description, is most fortunate, and for machines above 5,000 K.W. capacity, the double-flow construction will become standard in all Westinghouse work. For smaller capacities, the single-flow Parsons principle, as before, predominates, and in sizes below 3,000 K.W., the familiar Westinghouse-Parsons construction, therefore, remains standard.

From a thermodynamic standpoint, the Parsons is still the most efficient turbine system ever devised; but owing to the mechanical advantages inherent in the double-flow type, the net result is that as the two types are now built, they are practically upon the same basis as regards economy. This condition is largely brought about by the higher relative speeds permissible in large capacity machines with which the Parsons element works to so much better advantage as to compensate for the poorer inherent economy of the impulse section. In fact, this impulse element may be considered somewhat as a power producing reducing valve from which a lower efficiency may be countenanced.

Elemental Construction.

The advantages of the double-flow construction will probably be most clearly understood by first considering the low pressure double-flow turbine shown in Fig. 1. Here we have a turbine of the simplest possible construction, consisting entirely of two identical Parsons turbines placed end to end, taking steam at the center and exhausting at both ends. It will be evident by an examination of the illustration, that since the two elements are identical, and the steam flows through them in opposite directions, the axial thrust of the steam on the blades, due to the difference of pressure between the inlet and outlet of each element, will be exactly the same in both sections. Therefore, perfect steam balance under all conditions of pressure, vacuum and load, is obtained without the use of dummy or balance pistons. As these low pressure turbines are designed to utilize all the exhaust steam from a non-condensing reciprocating engine, it is possible to tie the engine and turbine together electrically, thus making the use of a governor on the low-pressure turbine unnecessary. With the exception that, as mentioned, the governor may often be omitted from the low-pressure turbine, it is practically identical with the high-pressure double-flow turbine. In fact, the high-pressure machine is directly evolved from the low-pressure by the simple addition of a high-pressure impulse element mounted at the center of the rotor, this simple element serving in a capacity closely analogous to the high-pressure cylinder of a triple expansion reciprocating engine. Fig. 2 represents the final step in the evolution of the present complete high-pressure machine.

Fig. 4. Section through a Blade showing the Copper Sheathing which is chemically welded to a Steel Core.

Features of the Double-flow Construction.

At this point it may be well to review some of the features of the double-flow turbine.

1. Large reduction in bulk and in weight of individual parts to be handled in assembling. These follow from:

2. Increased speed permissible, due to reduced span between bearings.

3. Low-pressure section in two parts opposed in position and resulting in axial equilibrium, permitting the use of low-pressure blading of moderate length.

4. Cylinder not exposed to high-pressure and high-temperature steam; maximum pressure encountered about 75 pounds.

5. Relatively large volume per pound of steam at admission to first Parsons section avoids necessity of very short blades otherwise necessary with large diameters.

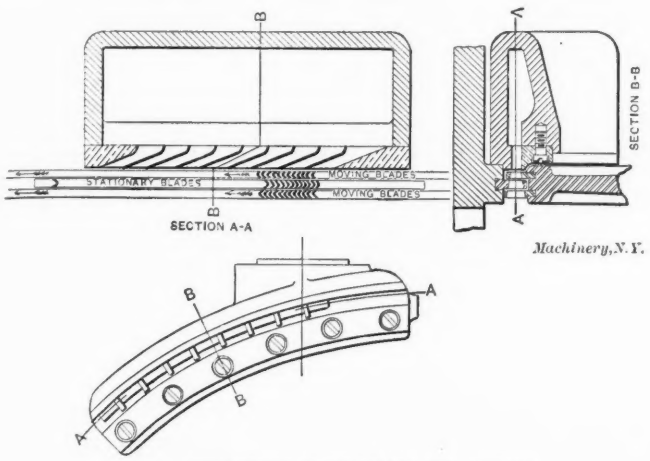


Fig. 5. Arrangement of the Blades and Nozzles.

6. Only one balance piston required, this being of moderate diameter.

7. Impulse element well suited to high-pressure and superheat; works well into dimension scheme, and reduces shaft length nearly 50 per cent.

8. Exhaust connections passing through bed plate largely reduced in size due to divided flow.

General Description.

Steam enters the turbine through a flanged opening in the lower half of the casing from which it is piped directly to nozzle blocks. For convenience in illustrating, the nozzle block, Fig. 2, is shown at the top, whereas, it may be located at any point in the periphery nearest the inlet. Expanding in suitable nozzles, the steam impinges upon the impulse blades, enters the impulse wheel chamber, and is distributed evenly around the casing so as to enter the intermediate Parsons section of the turbine, around the entire periphery of the rotor. As in the single-flow turbine, the steam then divides along two separate paths, one-half entering the left-hand section of low-pressure Parsons blading, the other passing through the interior of the rotor shell which forms the connecting passage to the remaining low-pressure section of Parsons blading at the right-hand end of the turbine. Discharging from the last rows of low-pressure blading, the steam passes into the exhaust connections and to the condenser in the normal manner.

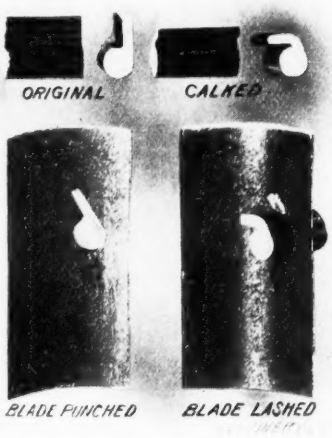


Fig. 6. The Improved Method of Blade Lashing.

As the same pressure exists on both sides of the impulse wheel disk, this is not subjected to end thrust and requires no balancing. The difference of pressure between the inlet and outlet of the Parsons intermediate section, is accurately balanced by a dummy piston of moderate dimensions, located between the impulse wheel and the right-hand low-pressure section. And since the thrusts in the low-pressure sections are in opposite directions and therefore balanced, the entire turbine runs in perfect equilibrium under all conditions of vacuum, pressure and load. It is, of course, necessary to provide means for accurately fixing the axial position of the rotor, and for this purpose, an adjustment bearing on the right-hand end of the shaft, is, as usual, fitted. It consists of a number of collars turned in the shaft, into which fit corresponding brass rings fixed in the adjustment blocks. The upper and lower halves of the adjustment bearing may be moved by means of micrometer screws, as shown, thus permitting the axial position of the rotor to be accurately known at all times.

Double-flow Cylinder.

All double-flow cylinders are made in two parts, the upper and lower halves each being a one-piece casting. The design is symmetrical throughout, devoid of longitudinal flanges except those at the center required for bolting the two parts together. The castings are first rough-bored, after the flanges have been planed and drilled, and are then "seasoned" with high-pressure steam for a number of hours to remove any local casting strains in the metal. They are then given the finishing cut, assembled, and with boring-bar running in the bearing housing so as to insure a truly concentric bore. Manholes are provided at each end of the cylinder to permit access for interior examination, and relief valves are fitted in each of the manhole covers to prevent the pressure in the exhaust passages rising to a dangerous point in case of failure of the condensing apparatus and sticking of the atmospheric relief valve. A steam- and air-tight packing gland is fitted at each end of the cylinder where the shaft enters, and will later be described in detail.

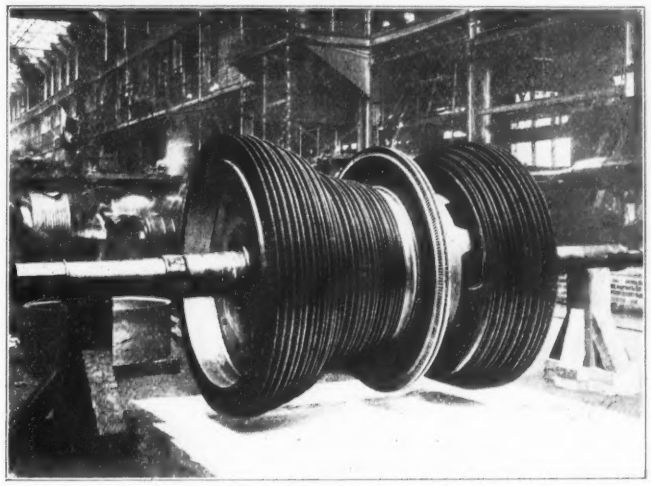


Fig. 7. View of the Rotor showing the Uniformity of the Blading.

A Y-connection fitted with two corrugated copper expansion joints located below the base of the turbine, connects the separate exhausts to the main exhaust nozzle. This is clearly shown in the longitudinal elevation of the 5,000 K.W. Brunot Island turbo-generator shown in Fig. 3. By means of these expansion joints, the desired freedom of movement of the turbine casing, due to expansion and contraction, is provided for. It will also be noted that an atmospheric exhaust nozzle opens out of the side of the exhaust Y to permit non-condensing operation.

The Rotor.

Referring again to Fig. 2, it will be seen that the rotor consists of five cast steel members mounted on a through shaft. Note that the shaft carries its load at one-third distance from the points of support, thus permitting a lighter shaft than required for distributed loading, and practically eliminating the possibility of deflection. The rotor is firmly pressed on the shaft and locked to prevent movement. To the left end of the rotor is fitted a bronze bushing surrounding the shaft, permitting it to move axially without appreciable resistance under any differential expansion of shaft and rotor body.

The impulse element consists of a flanged cast steel disk forced onto the rotor body with a pressed fit and securely keyed. The flange at the base is grooved and forms the dummy or balance piston for the intermediate Parsons section.

A typical arrangement of blading and nozzles is shown in detail, Fig. 5. Note that the nozzle block is an independent casting quite separate from the turbine cylinder. This restricts the high pressure and high temperature of the steam received from the governor valve to a comparatively small casting which is free to expand and contract with changes of temperature, and may easily be designed with ample strength.

As the steam is not expanded in the impulse element to less than about half of the initial pressure, divergent nozzles are unnecessary and simple straight-sided nozzles are used. The entire nozzle block may be removed in one piece, and the construction is such that the nozzle walls may be readily renewed if necessary, at a very nominal cost, independently of the block. As practically no difference of pressure exists on the two sides of the element, the area through the bucket increases, to provide for the decreasing steam velocity in each rotating wheel. As in all high-pressure impulse turbines, the nozzle blocks cover but a small portion of the periphery of the impulse wheel, so that ample space is left around the remaining portion of the wheel to permit the free circulation of steam in all parts of the impulse wheel chamber before entering the Parsons element.

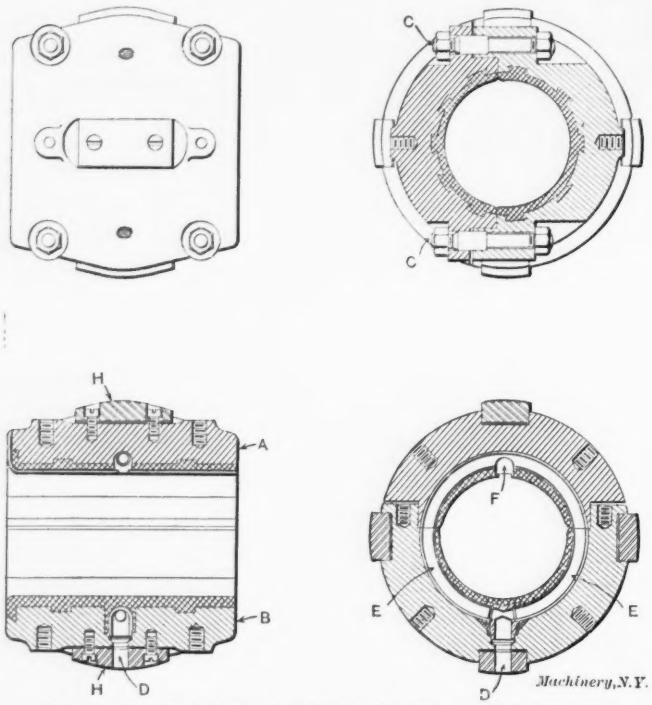


Fig. 8. The Self-aligning Babbitt-lined Bearing, which does not require Forced Lubrication.

Parsons Element.

Except for the division of the low-pressure Parsons section, this part of the turbine is identical with the single-flow construction, consisting of a series of rows of moving and stationary blades, increasing in height to allow for the increased volume of the steam. In the Parsons section, it will be recalled, the velocities from stage to stage remain practically constant. The blades are inserted in grooves cut in the spindle and cylinder body, and are securely held in place by calking the soft spacers or distance pieces inserted in the grooves between the blades. It will be noted that the diameters of the low-pressure section are chosen so as to permit the same size blades being used in both intermediate and low-pressure sections, thus simplifying the blading considerably. As there are a number of improvements in the Westinghouse-Parsons blade construction used on both the single-flow and double-flow turbines that have not been previously described, they will be of interest.

The Blading.

No one metal has all the physical characteristics desirable in a blading material. But recently a special, compound metal has been developed, which is exclusively used in Westinghouse turbines. This material, known as "Monnot," or duplex metal, consists of a steel core covered with a thin copper sheathing chemically welded to the steel in such a perfect manner that the blades may be drawn cold from the original ingot into the required finished section without in any way affecting the bond between the copper and steel. The advantages of this blade material will at once be evident, as experiments have shown that pure copper offers the maximum resistance to chemical corrosion resulting from bad feed water carried over in the steam during priming. At the same time the integrity and great strength of the steel core is maintained. How uniform the copper sheathing of the finished blade is, may be clearly seen in Fig. 4, showing an enlarged section of a duplex metal blade, the end of which has been etched to show the true thickness of the copper covering.

Fig. 9. Westinghouse Low-pressure Double-flow Turbine.

The Blade Lashing.

The original method adopted for reinforcing long blades was to insert a heavy brass wire in saw slots cut in the entrance edge of the blade, the brass wire being securely laced to the blades by a thin copper wire, and the whole then rigidly brazed together. This method has been greatly improved upon in the present blade lashing now used in all Westinghouse turbines, shown in detail in Fig. 6. First, comma-shaped holes are punched in the blades at any desired point of reinforcement. The blades are then strung onto a comma-shaped lashing wire laced through these holes. After the blades have been calked into the rotor or stator, the tail of the lashing is sheared over by a tool, as shown in the accompanying engraving, Fig. 6. This process wedges the tail of the lashing (comma section) into the contracting space between the face and back of the adjacent blades, acting as a strut, while the lashing wire itself acts as a tie, thus securely interlocking the blades and preventing vibration. Moreover, the short section remaining in the blade after being sheared off, acts as a key to prevent a broken blade from injuring adjacent rows. The quality and uniformity of the blading secured by these improved methods, is indicated in the view of a rotor, Fig. 7.

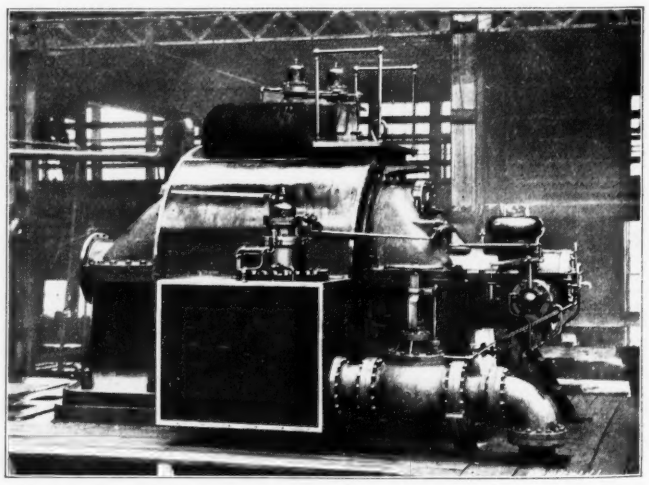


Fig. 10. One of the 5000 K.W. Double-flow Turbines installed at the Brunot Island Station of the Pittsburg Railways Co.

The Packing Glands.

A water-sealed gland is fitted on each end of the turbine shaft where it passes through the exhaust casings. This pack-

ing consists of a small centrifugal pump propeller running in an enclosed chamber to which water is supplied under a head of about ten feet, which is slightly in excess of the head due to the centrifugal force acting on the water in the impeller blades. At starting, any external leakage water is caught in circular troughs and drained away. The action of this gland is to always maintain a solid mass of water around the periphery of the impeller which effectually prevents the entrance of air to the condenser or the escape of steam to atmosphere when running non-condensing.

The Bearings.

As in all Westinghouse turbines running at or below 1,800 R. P. M., self-aligning babbitt-lined bearings are used, of sufficient area to operate without the use of a forced-lubricating system. One of these bearings is shown in detail in Fig. 8. It is made in two parts, supported in a spherical seat by four pads, by means of which the bearing and rotor can be accurately centered to preserve uniform clearances. The oil supply to the bearings is delivered at the top of the journal at the point of minimum pressure, which assures an even distribution of oil. All the bearings are supplied with oil from a central reservoir, under a static head of about 5 feet.

* * *

The Standard Oil Co. has been the chief exponent of subterranean business methods. Its greatest success has hinged largely on the policy of secretiveness, though John D. Archbold, the vice-president and chief spokesman of that great business machine, asserted in the *Saturday Evening Post* some months ago that the policy was not, in his opinion, the best one to follow. He stated that while perhaps the financial returns would not have been quite so vast, the concern would stand in much better repute to-day if a franker policy had been followed. We mention this because there is a marked tendency among certain small concerns to seclude their work with more or less mystery. They assert it is more to their advantage not to let their activities be widely known. The less there is known about their work the less fierce will the competition be. While we do not deny that there is some truth in this claim, we believe that it is an unsafe policy for the average small producer to follow. Working under cover, his product will necessarily be known and bought by comparatively few customers. So long as these customers absorb all his product, well and good, but when some of these customers drop out, as they inevitably will, the producer will be stranded high and dry until he can secure new customers, and these are not always readily picked up. When they are found it is quite probable that they will demand changes that will be very costly. If, on the other hand, the concern was generally known, the loss of one customer would not be so serious a matter, and moreover, the business would be conducted more closely in accordance with the general development of the art.

* * *

A new technical high school is being erected in Cleveland, Ohio, and will be completed next September. It is claimed that this institution is the largest of its kind in the United States. It will have accommodation for about 1,000 regular students, and is well equiped with laboratories for physics and chemistry, a forge shop, a machine shop with heavy equipment suitable for the best of trade instruction, an iron and brass foundry, completely equipped with core-room, core ovens, etc., a power plant for generation of the electric light and power required in the building, a pattern-making shop, and departments for instruction in joinery, wood turning, and cabinet making, etc. The mechanical equipment will cost in the neighborhood of $100,000. All machines will be driven by individual motors. An innovation in the instruction will be that, by eliminating the long summer vacation, a saving of an entire year in the high school course will be accomplished, so that a three-year course will be offered in which work usually covered in four years can be completed. In addition to the day classes, there will be night classes for men and women already engaged in the trades. These night classes will be divided in two sections, each accommodated three nights a week from 7 to 9:30. In this way the night trade school can give instruction to 1,400 men and 600 women.

ALIGNMENT TESTS OF LE BLOND MILLING MACHINES.

In the April, 1904, issue of MACHINERY a general description was published of the then comparatively new plant of the R. K. Le Blond Machine Tool Co. in Cincinnati, and in the article a set of boring-bars and reamers for boring the

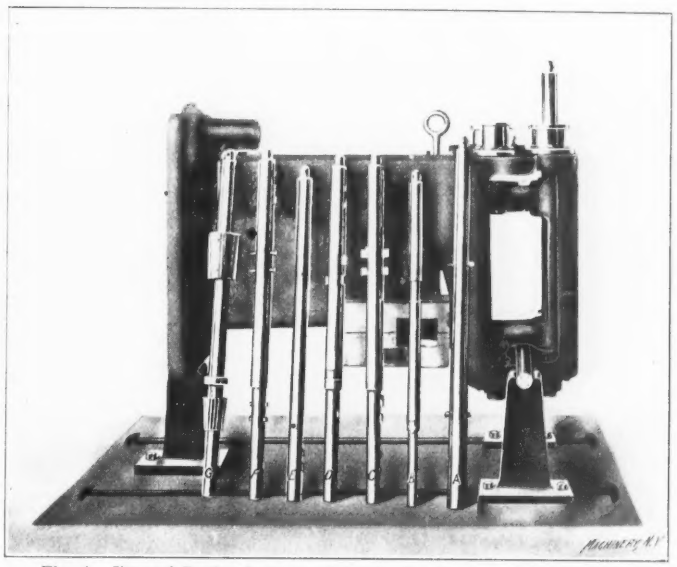
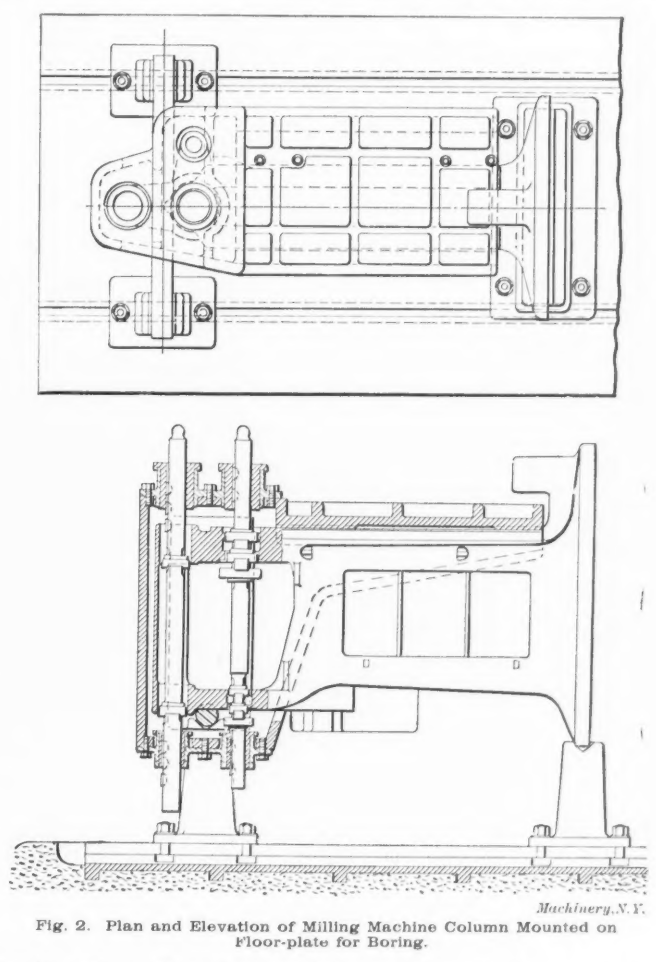


Fig. 1. Jig and Boring-bars used for Boring Bracket Holes, Spindle Bearings, and Over-arm Hole.

bracket holes, main spindle bearings and the over-arm holes of the Le Blond milling machines was illustrated. These tools, whose proper working is so necessary to the accurate alignment of a milling machine, are again reproduced in Fig. 1 in connection with illustrations of the alignment tests to which all Le Blond milling machines are subjected on the



Machinery, N. Y.

Fig. 2. Plan and Elevation of Milling Machine Column Mounted on Floor-plate for Boring.

testing floor. For the description of these tests we are indebted to Mr. William F. Groene, the superintendent of the company.

Before passing to the alignment tests, attention is called to the manner of supporting the machine column during the boring operation, and to the construction of the boring jig

shown in section in Fig. 2. Formerly the milling machine column was supported on a three-wheel truck for convenience in transporting to and from the drill press, but now the truck is displaced by an electric traveling crane, and the support is a cast iron floor-plate, bedded in concrete and provided with suitable pedestals for the column casting. It may be said in passing that the boring-bars are entirely supported by the boring jig, and that the power from the radial drill press is transmitted by a "floating" or universal joint connection. The jig bushings are mounted in protected bearings, proof against chips and drill dust, and are keyed so as to revolve with the boring-bar, thus eliminating the wear of the bars and preserving a close fit. The jig encloses the upper part of the column and is supported by the front face of the column and produces holes at right angles to this face.

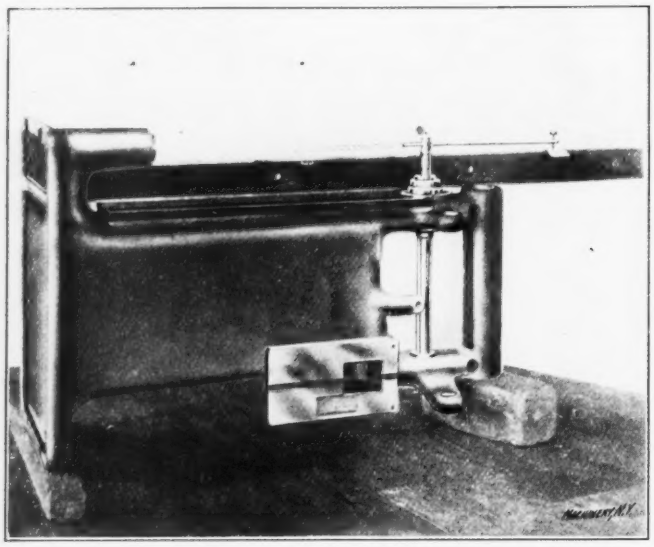


Fig. 3. Aligning Test made when Scraping Boxes Square with Face of Column. The Test is made Alternately at Top and Bottom by Drawing Tissue Paper between Straight-edge and Tram.

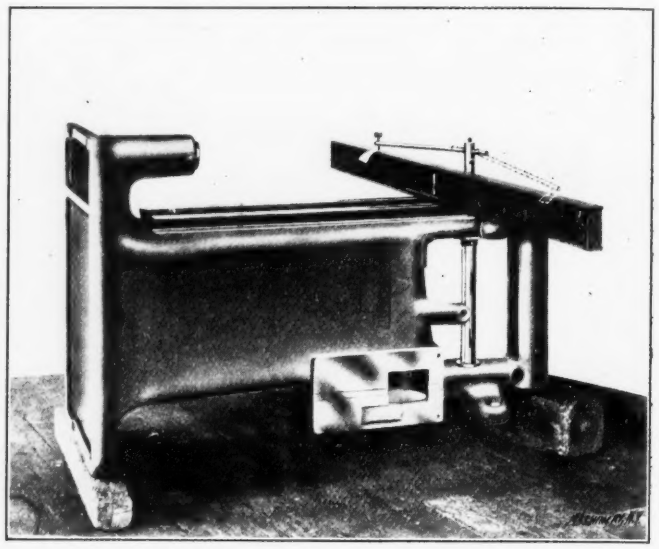


Fig. 4. Aligning Test made when Scraping Boxes Square with Face of Column. Same Test as in Fig. 3, except that Straight-edge is Laid across Column.

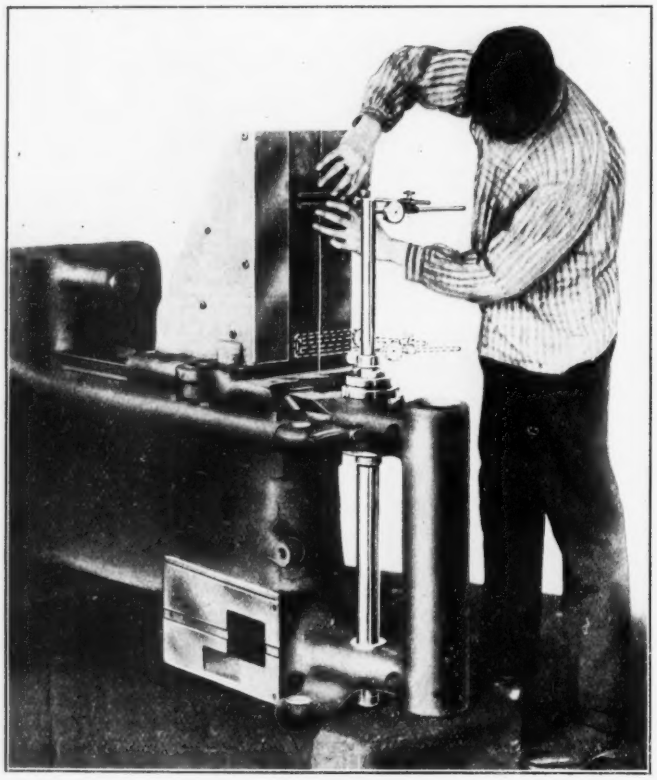


Fig. 5. Aligning Test used in Scraping Knee to Column, to determine the Alignment of the Side Bearing Surface of the Knee with the Spindle.

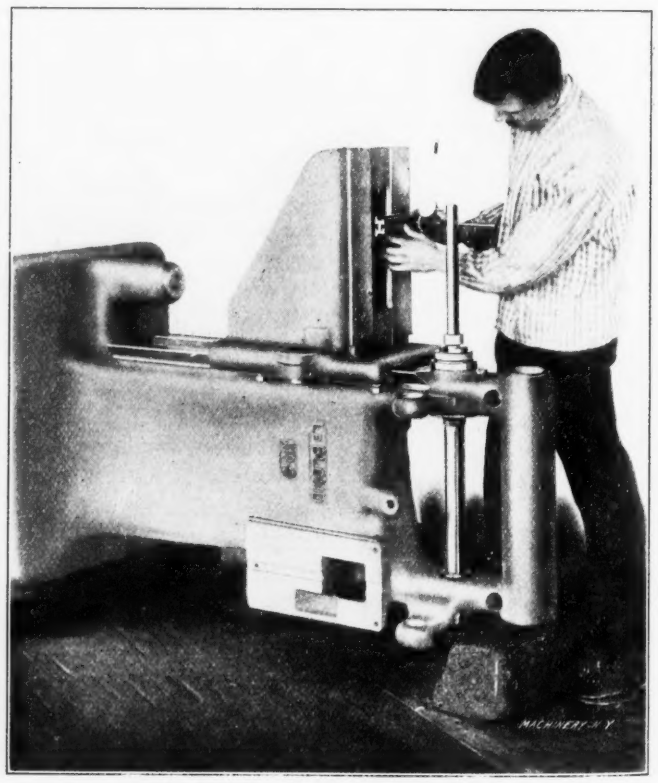


Fig. 6. Aligning Test used in Scraping Knee to Column, to determine the Parallelism of Top of Knee with Spindle.

It is one thing to design a jig for boring holes at right angles to a given surface and perfectly parallel, and quite another thing to get the desired result, especially in the case of a milling machine column casting. Eternal vigilance is necessary to keep the tool equipment in order, and rigid tests are required of each casting. No ordinary jig, no matter how carefully planned, can produce an invariably correct alignment in long holes, especially in irregular castings, which are cored and shaped to save weight, and in which shrinkage strains are always present to some extent. The slight changes of shape caused by the removal of metal from the holes would in themselves require some corrective work, even if the jig always provided perfect guidance to the boring tools, and the fine touch of the experienced fitter is employed to correct these and other minor defects of important influence on the alignment. The tests to be described are employed to show where the scraper should be applied, as well as to prove that the work is finally worthy of acceptance.

The columns are scraped to surface-plates before boring. Boring-bar *A* and the bar shown in the jig in Fig. 2 are the over-arm finishing and roughing bars, respectively. The bar designated as *B* is for roughing out the back-gear bracket holes, and *E* is the finishing bar. The boring and reaming bars for the spindle bearings are *C*, *D*, *F*, and *G*, *C* being the roughing bar. This bar has extra slots for receiving larger cutters to do the counterboring, and *F* is the finishing bar. Bar *D* is used for boring the holes to the correct taper, the

cutters having their faces chamfered to the required taper of the bearings. These cutters are set opposite to each other to balance the cut. *G* is a bar with adjustable taper reamers for finally reaming both bearings true at one operation.

face of the column by scraping the bearings of the front and back boxes. No error is allowed in this alignment and the trams must show the same in the test when in the four positions shown.

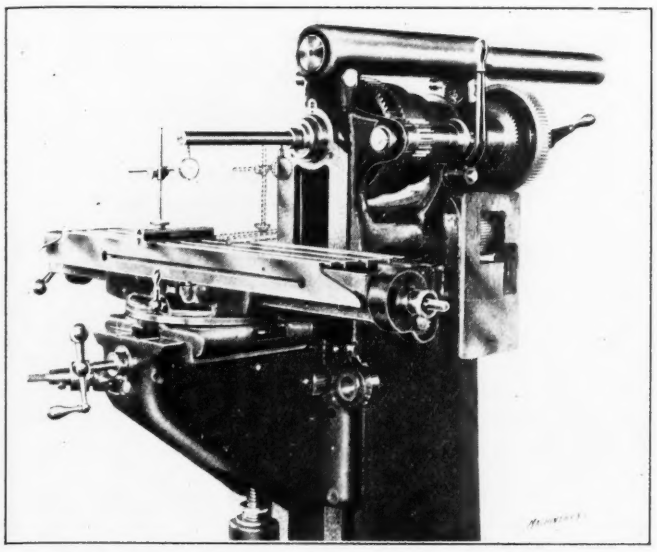


Fig. 7. Test to show Parallelism of Table with Spindle, and to indicate if Taper Hole runs True. Test is made by shifting Indicator across Table.

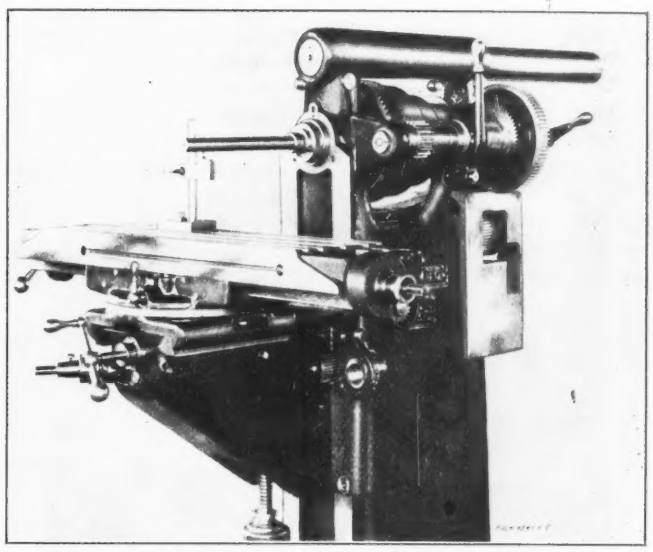


Fig. 8. Test to show Parallelism of Knee with Spindle. Test is made by clamping Indicator to Table and moving Saddle across Knee with Screw.

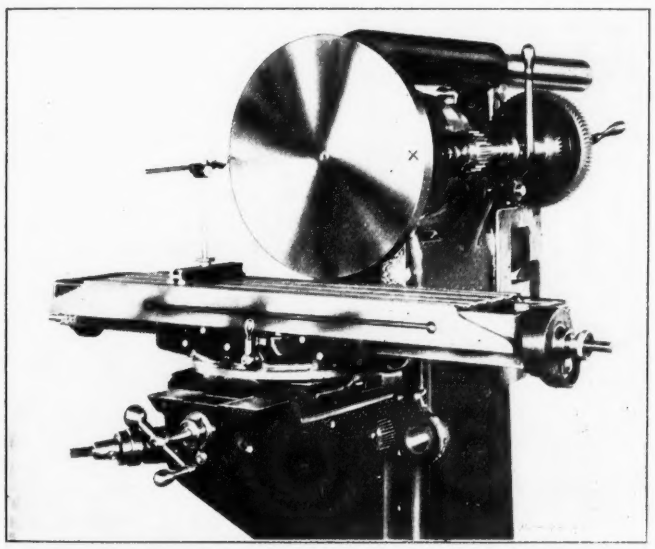


Fig. 9. Testing Alignment of T-slot with Spindle; Reading taken as shown, and on other Side of Spindle at X, with Plate turned One-half Revolution.

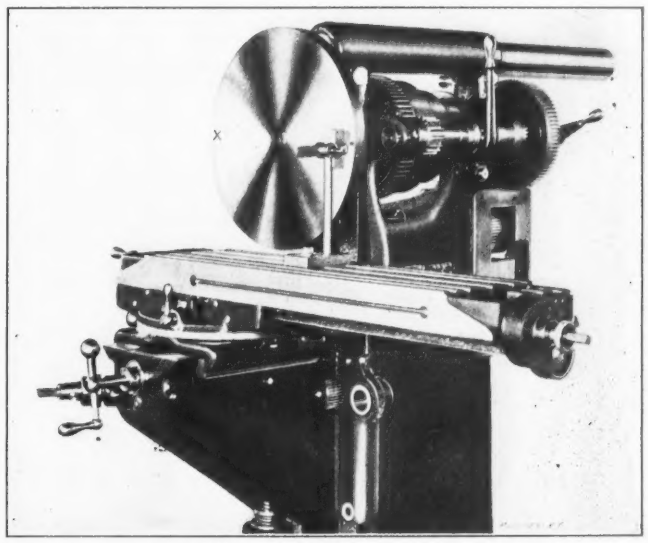


Fig. 10. Testing Alignment of Table Feed with Spindle. Indicator clamped to the Table and traversed past the Test Plate. Test otherwise made as in Fig. 9.

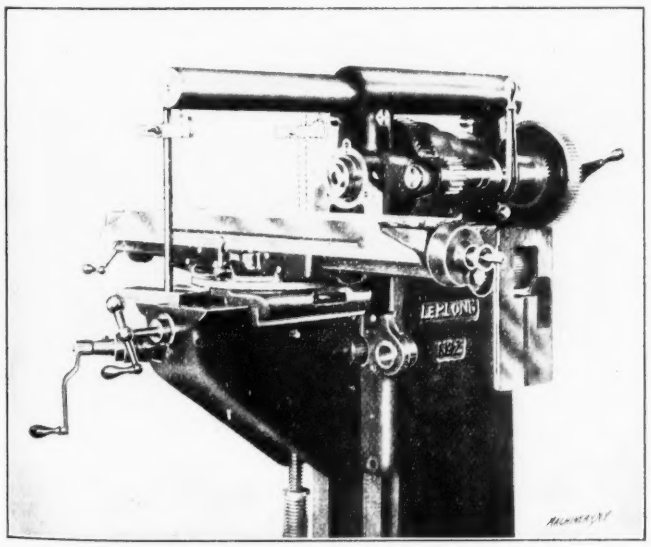


Fig. 11. Test to determine Alignment of Over-arm with Top of Knee. Indicator is passed under Arm on Each Side of Saddle.

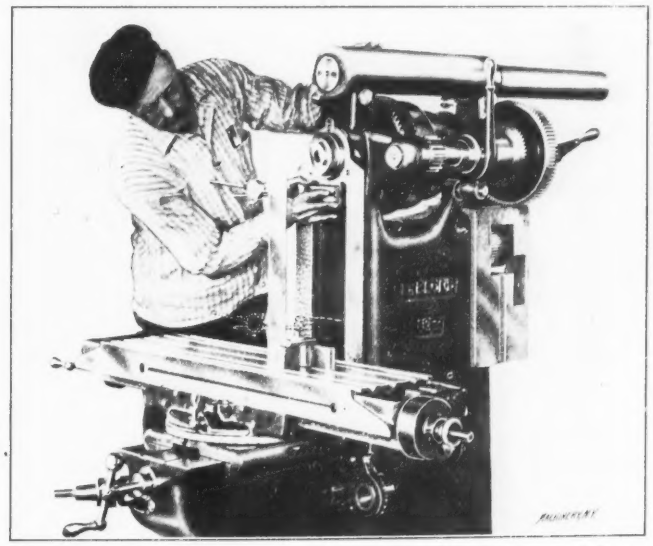


Fig. 12. Testing Truth of Table Top with Side of Column. A Test for Truth with Face of Column is made with Square Clamped at Right Angles to Position shown.

The columns, as bored, come within an included error of about two thicknesses of tissue paper, or say 0.003 inch, when tested with the 18-inch trams and straight-edge, as shown in Figs. 3 and 4. The spindle is then lined square with the

Figs. 5 and 6 illustrate the test made while scraping the knee to the column. The test bar is inserted in the spindle and the knee is tested both with the face and side of the dovetail with the dial indicator. The base of the indicator has a

shoe which bears against the side of the column when making the test.

Fig. 7 illustrates testing the top of the table for parallelism with the spindle. In this case the indicator is set to the under side of the test bar and is moved across the table, the error being read in the two extreme positions as indicated in the illustration.

Fig. 8 shows the indicator clamped to the table while both the saddle and table are moved across the knee. This test proves the parallelism of the knee with the spindle.

Referring to the test card, it will be seen that the limit of error is 0.0015 to 0.003 inch high in front for No. 1 to No. 2½ machines, and 0.0025 to 0.004 inch high in front for Nos. 3 and 4 machines. The knee and table are designedly made high in front, the object being to more nearly approximate

TEST CARD

No. 2½ Universal MILLER
No. 315 Date completed 3-19-08 Insp. Nielush
Shipped to Dodson Mfg. Co. Torreon Mexico

Front Spindle Bearing adjustment		✓
Rear " " "		✓
Spindle revolves freely without shake		✓
Taper hole has good bearing		✓
Back Gears run quietly		✓
Overarm Locking Plugs have good bearing		✓
Feed Box properly fitted up		✓
Feed Box Gearing run quietly		✓
Feed works in Knee properly fitted up		✓
Crank Handles fit squares in all positions		✓
Dividing Head Change Gears fit stud freely		✓
Knee Saddle and Table Gib Screws properly adjusted		✓
Movements as specified by Catalog		✓
Automatic Table, Cross and Vertical Feed trip to a line		✓
Safety Trip Dogs properly set		✓
	Limit of Error	**Test**
Table Screw, test every 4"	.0005	.00025
Vertical " "	.0005	OK
Cross Feed "	.0005	OK
ALIGNMENTS:		
Taper hole in spindle runs true—error at outer end with 16" test bar	.001	.001
Knee parallel with spindle—test full cross movement of saddle	.0015–.003 high in front for No.1-2½ .0025–.004 high in front for No.3 & 4	.0015
Top of Table parallel with spindle—test at extremes 16" test bar	.0015–.003 high in front.	.002
Top Table square with side of column test at extremes 24" precision square	.0015–.003 in favor	.002
Top Table square with face of Column test at extremes 24" precision square	.0015–.003 high in front for No.1-2½ .002–.004 high in front for No.3 & 4	.002
Table travels at right angles to spindle test at extremes 20" test plate	.0015–.003 in favor	.0015
Table T-slots at right angles to spindle test at extremes 20" test plate	.0015–.003 in favor	.0015
Overarm parallel with spindle & knee test at each end of knee	.002–.003 low in front	.0025

Fig. 13. Test Card giving Required Tests and Maximum Permissible Errors.

correct alignment after the machine has been in use a few months and has worn down to full bearing under the pressure of the cutters.

The testing of the alignment of table T-slots with the spindle is illustrated in Fig. 9. The indicator base has a tongue which fits into the T-slots. The indicator point is set against the test plate, screwed onto the spindle, which is then given half a turn, and the indicator is moved to the opposite side to read the error. A cross mark is made on the face-plate, as shown in the illustration, to note the testing point. Fig. 10 shows the same test as Fig. 9, but in this case the indicator is clamped to the table which is traversed across the test plate, and the difference of reading in the two positions is noted as before. This test gives the error of the table at right angles to the spindle with reference to the table dovetails. It will be noticed in the test card that allowance 0.0015 to 0.003 inch is permitted at the extreme of a 20-inch test plate in favor of the direction against the feed. This allowance is for the same reason noted before. When the machine has been in use a few months it will have worn down under the pressure of the cut until nearly perfect right angle position has been obtained.

This practice is worthy of further mention because it is of much importance to users of machine tools and to buyers of second-hand machinery. It means that a well-constructed milling machine is actually in better shape after it has been used for a short time than when new. Given data of tests made on used machines, it would be possible to plot the matter graphically and show the probable condition as regards accuracy of alignment for several years. Starting with 0.0015 to 0.003 inch inaccuracy, the conditions would be plotted probably as a reverse curve, rising from a position below the zero line in three or four months daily use, and then with ordinary good care paralleling and nearly coinciding with the zero or dead accuracy horizontal line for several years use. The departure of the curve from this zero line upward into the zone of negative inaccuracy, if we may name it so, would be relatively rapid or slow, depending on the care the machine receives and the class of work assigned to it.

The test of the alignment of the over-arm with the top of the knee is shown in Fig. 11, and in Fig. 12 two tests are indicated which are made with a 24-inch precision square to determine whether the top of the table is at right angles to the face and side of the column.

The test card we reproduce shows all the tests regularly made and the maximum permissible error allowed for the various sizes of machines built by the company. This card was made for machine No. 315 and is the one from which the photographs here reproduced were made.

* * *

An interesting kink in hack-sawing was shown to the editor in the shop of the National Tool Co., Cleveland, Ohio, by Mr. E. A. Noll, the manager. Most users of hack-saws have trouble in sawing large diameters of stock, especially tool steel, by the saw "running" and perhaps breaking before the end of the cut is reached because of becoming cramped. Mr. Noll has found that the saws will run dead true if they are slightly twisted when tightened up in the saw frame. Milford saws are used on hard tool steel stock and the blade is twisted very slightly in the frame when tightened up. Twisting a hack-saw to produce a straight cut is contrary to all preconceived notions, but the explanation seems logical. The explanation is that the saw being slightly twisted to begin with resists any tendency to deflect it from its plane of action much more strongly than it would if it were put perfectly straight in the frame. The initial twist given is so little as to have little or no effect on the cut, but it is sufficient to prevent the saw being twisted out of its plane by slight differences in the hardness of the material and other influences which tend to cause a saw to run out.

* * *

In the March, 1908, issue of MACHINERY we described the Automobile Club of America's dynamometer for testing automobiles, and mentioned that the mechanical efficiency of automobiles in general was rated at 75 per cent, but many of those tested on the dynamometer showed less efficiency. The consensus of opinion is that mechanical efficiency should be higher than 75 per cent, if anti-friction bearings were used, and it is interesting to note the results of efficiency tests made by the H. H. Franklin Co. recently. The car tested was the Franklin model G standard touring car. It gave on direct drive for 15.75 H.P. developed by the motor, 14.75 H.P. delivered at the ground. On intermediate drive the figures were 15.75 H.P. and 14.40 H.P. The loss in transmission between motor and rear wheels was 6 2/3 to 8 1/2 per cent, thus making the efficiency for the total mechanism 93.5 per cent on direct drive and 91.5 on intermediate gear.

* * *

No experienced mechanic needs to be told that the universal milling machine is a complete machine shop in itself. With the various attachments now provided it is possible to produce circular, plane and helical surfaces and combinations in almost every conceivable arrangement. Milling, turning, slotting, spur, spiral and bevel gear cutting, forming, cam cutting, drilling, reaming, boring, splining, knurling, thread cutting, thread milling, originating jigs, hobbing, etc., are all readily accomplished. Instead of being called a universal *milling* machine, it should be called the *universal* machine.

GEAR-CUTTING MACHINERY—6.

RALPH E. FLANDERS.*

As explained in the last installment of this article, in the May issue of MACHINERY, the molding-generating principle is the only one for accurately forming the teeth of worm-wheels. The principle involved is shown in Fig. 111. The forming worm (or hob) is connected by gearing with the plastic worm-wheel blank to be formed, in the same ratio as given by the finished worm gearing. While the blank and the forming worm

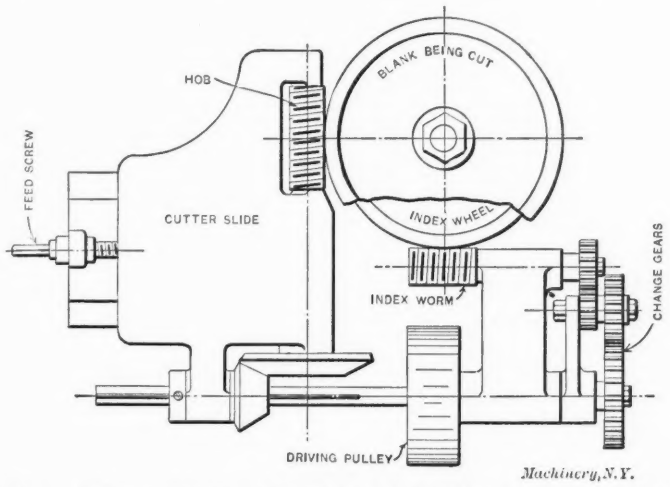


Fig. 111. Diagram showing the Principle of the Hobbing Process for Cutting the Teeth of Worm-wheels.

are rotated together in this ratio, the latter is fed into the blank slowly, its threads forming the proper shaped tooth in the wheel. As the worm revolves, an axial section would give the appearance of a rack like that shown in section *A-A*, of Fig. 109, moving continuously and forming suitable gear teeth in the wheel below it. Any other section, such as *B-B* in Fig. 109, would also act as a distorted rack, forming correspondingly distorted gear teeth in that portion of the worm-wheel in the same plane. The process is thus seen, as previously explained, to be identical with that in Fig. 7.

Of the various methods of operation, shaping or planing is of course impracticable. Milling is the method generally employed. Grinding or abrasion is used to a limited extent, it being sometimes employed in the case of "grinding in" a worm with a wheel already roughly cut to shape. In this operation the worm and wheel are run together in place under considerable pressure, the teeth of the gear being liberally supplied with oil and emery, which acts as an abrasive and forms the teeth of the gear and worm to fit each other.

In the commonly employed milling operation, the process is that known as "hobbing," and the milling cutter or tool

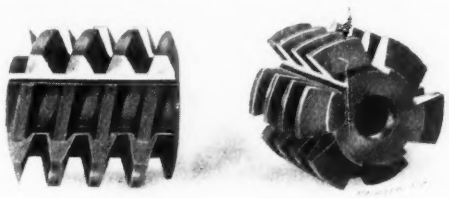


Fig. 112. Side and End Views of Hob.

used is a "hob," of which an example is shown in Fig. 112. The hob (barring modifications required for relief or clearance, and allowance for regrinding) is practically a replica of the worm which is to be used, but with grooves cut in it so as to form teeth. This hob is rotated in the proper ratio with the work, exactly as shown in Fig. 111, and fed slowly down into it, cutting out the tooth spaces in the wheel as it does so. When it has reached the proper depth, the teeth are all formed to the proper shape.

Hobbing Worm-wheels in the Milling Machine.

The simplest method of rotating the hob and the work in the proper ratio with each other is that in which the work is first gashed, as shown in Fig. 110, and then finished with the hob in such a way as to be driven by the latter, the work and the hob thus furnishing their own driving mechanism. The same wheel which is being gashed in Fig. 110 is shown having its teeth finished to the proper shape with the hob in Fig. 113, the hob driving the work as described. The latter is mounted so as to revolve freely on dead centers. This is the simplest method of making correct worm-wheel teeth. It does not require special appliances of any kind, being done in an ordinary milling machine with a gashing cutter and a hob.

In cases where it is desired to hob worm-wheels directly from the solid without preliminary gashing, it is necessary to provide some special device for rotating the hob and the work in unison as in Fig. 111. Such a case is shown in Fig. 114, which illustrates the worm-wheel hobbing attachment built by the Wanderer Fahrradwerke, Schonau, bei Chemnitz, Germany. This attachment, which is self-contained, is clamped to the table of the milling machine. The device carries a vertical work spindle, driven by a worm and worm-wheel which are connected by change gearing with a horizontal shaft carrying a gear meshing with a gear on the spindle of the machine. The hob, which is carried by the spindle of the machine, is thus positively connected through the change gearing with the work in the same way as in Fig. 111. Change gearing is set to give the proper ratio between the hob and the work. The hob is fed to depth in the work by the operation of the regular table feed-screw.

In Fig. 115 is shown a hobbing attachment applied to another form of miller, in this case a horizontal spindle machine of the planer type made by the Newton Machine Tool Works, Philadelphia, Pa. The attachment consists primarily,

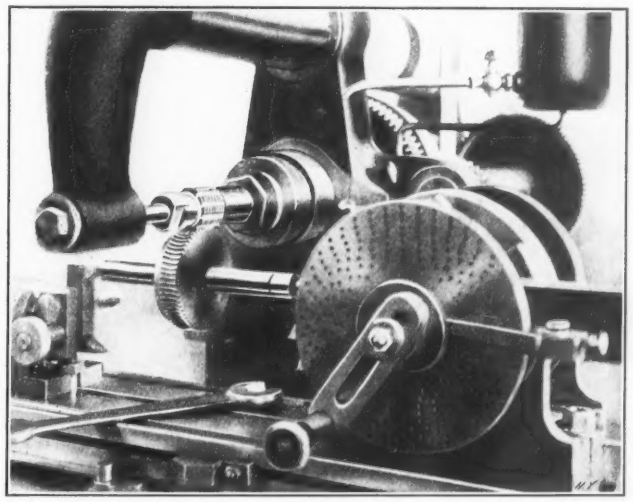


Fig. 113. Hobbing a previously Gashed Worm-wheel on Dead Centers in the Milling Machine.

as in the previous case, of a base provided with bearings for a vertical spindle, which is revolved by a worm-wheel enclosed within the base. The worm is connected by change gearing with a splined shaft, driven through a train gearing from the spindle. The machine is set to the diameter of the work, and the hob is fed to depth by the operation of the regular longitudinal feed-screw. A special feeding mechanism is provided, operated from the attachment instead of from the regular feed cones.

Hobbing Worm-wheels in Machines Designed for Cutting Other Forms of Gearing.

With slight changes, the orthodox spur gear cutting machine can be adapted to hobbing worm-wheels. An example of such an adaptation is shown in Fig. 116, the machine adapted in this case being an automatic gear-cutter made by Eberhardt Bros. of Newark, N. J. In this machine the indexing mechanism is operated from the same splined shaft by which the spindle is driven, so that, to obtain the proper ratio of movement between the hob and the work, it is only necessary to connect the index gearing positively with the driving shaft, instead of using the intermittent indexing motion ordinarily employed. With the index gearing thus permanently connected with the spindle driving mechanism, proper change gears may be selected to give the required ratio of movement between the worm-wheel to be cut (which is, of course, mounted on the work arbor) and the hob, car

* Associate Editor of MACHINERY.

ried on the cutter spindle in place of the regular spur gear cutter. Another provision that has to be made is that for feeding the cutter into the wheel as the work progresses. This is effected in this case by lugs on the arms of the index wheel, which, rotating continuously, act on a link mechanism which operates an adjustable ratchet motion for the vertical

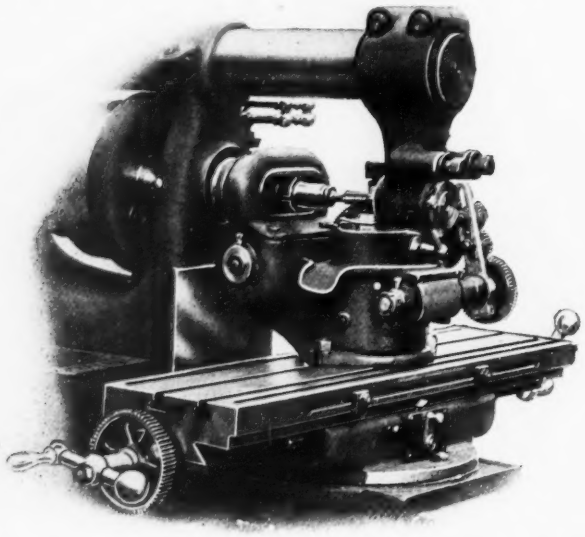


Fig. 114. Hobbing a Worm-wheel without Previous Gashing, in a Positively-driven Attachment in the Milling Machine.

feed shaft. This ratchet motion may be varied to give any rate of feed desired. By this means the work is fed down into the cutter as the operation progresses.

In Fig. 117 is shown a gear-cutting machine, made by Gould & Eberhardt, Newark, N. J., arranged for hobbing worm-wheels. In this case, also, the hob and the work are connected by means of the splined driving shaft and the index gearing, so that they revolve in unison and in the proper ratio. It will be seen that the work in the machine is so heavy as to make it advisable to support the outer end of the work arbor by means of the outboard bearing regularly pro-

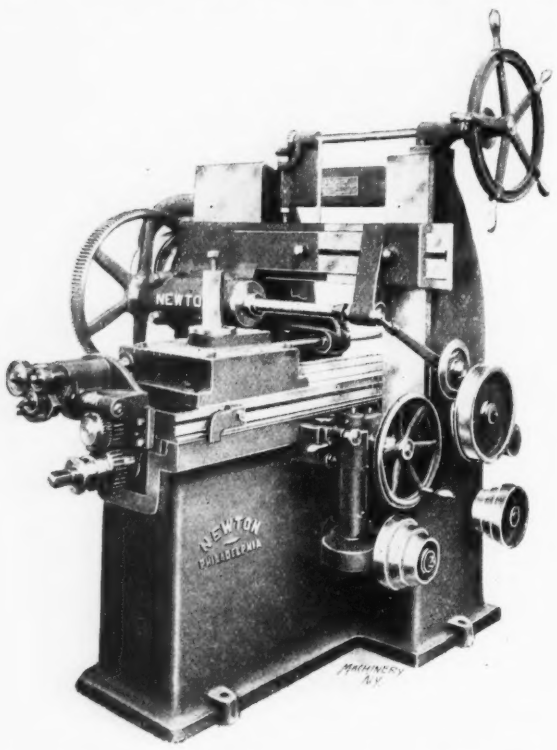


Fig. 115. Positive Hobbing Attachment used in the Newton Milling Machine.

vided for that purpose. To permit the downward feeding of the wheel, necessary to sink the cutter in to depth, the adjusting screw of this outboard bearing and the elevating screw of the work spindle head are geared together, so that they work in unison. The feed movement is applied to these two screws in such a way as to gradually lower the work into the cutter as the two revolve together.

All of the various gear-hobbing machines we have shown in Figs. 51 to 57 and 98 to 108 are adapted to the hobbing of worm gears without requiring special attachments of any kind. The only requirements in addition to the mechanism needed for hobbing spur gears, is the provision of a feed mechanism for sinking the cutter in to depth. The work saddles or tables of all these machines are, we believe, provided with this feed movement. The gearing for revolving the work and the hob in proper ratio with each other is of course embodied in the design of this type of machine. In Fig. 118 is shown one of these hobbing machines (the Grant-Lees machine of Fig. 104) engaged in hobbing a worm gear.

In addition to the machines we will describe later in which, though the hobbing process may be used, different movements are involved than in the cases we have been considering, special hobbing machines have been built from time to time, identical in their action with the various machines shown in Figs. 114 to 118. Most of these machines have been specially

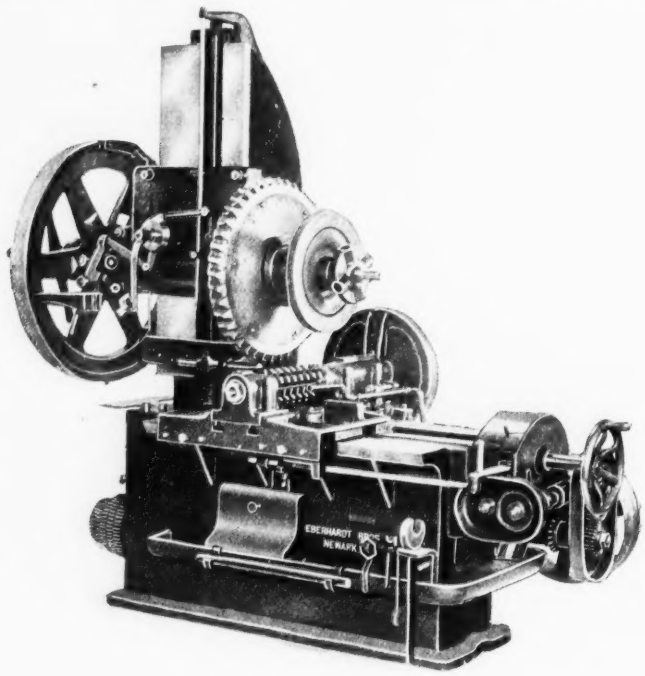


Fig. 116. Eberhardt Bros. Gear-cutting Machine arranged for Hobbing Worm-wheels, with Rachet Feed operated from Index Wheel.

built to suit the requirements of the user, without conforming to any settled type or design; very few of them have been built as a commercial product to be placed on the market.

The Fly-tool Method of Cutting Worm-wheels.

By providing suitable driving and feeding mechanism, it is possible to use a simple fly-cutter for forming the teeth of worm-wheels in place of the expensive hob used in the operations previously described. The movements required for this method will be understood from a study of Fig. 119. Here is shown in dotted lines a worm meshing with a worm-wheel, a portion only of whose periphery is seen. As previously described in referring to Fig. 109, such a worm, properly located with reference to a plastic blank and rotating with it in the proper ratio, will form accurate teeth in the latter by the molding-generating process. As we have also previously described, gashing this worm makes of it a cutter by means of which the same form may be given to a blank of solid metal. The teeth of such a gashed hob coincide with the outlines of the thread of the worm.

In Fig. 119, in full lines, is shown a cutter bar with a blade T_1 of the same outline as the thread of the worm and the tooth of the corresponding hob. In order to permit this single cutting tool to perform the function of the worm as it molds the plastic substance, or of the hob as it cuts its shape in the metal, it must be fed helically as the bar and work revolve, following the outlines of the imaginary worm from one end to the other as the cutting progresses. Beginning at the left, for instance, the blade may be fed helically in the line of the thread, passing through positions T_1 and T_3, until the feed finally runs out at the extreme right.

The methods of giving this progressive helical change of position to the fly-cutter are various. It would be possible, for instance, to so connect the feed-screw by which the cutter-bar is advanced with the rotating mechanism for the bar, through differential and change gearing, that a rotating movement due to the axial feeding of the latter would be added to or imposed upon the rotation due to its connection with the work, just as, in Fig. 97, the rotation due to the downward feed of the cutter slide is combined with that due to the connection with the cutter spindle for rotating the work. If the proper change gears were selected so that, with the spindle- and work-driving mechanisms stationary, the feeding forward of the cutter bar would rotate the latter at the proper rate to give the lead of the work, the blade would evidently follow the path of the thread of the imaginary worm, as shown at T_1 and T_3 in Fig. 119. Owing to the action of the differential

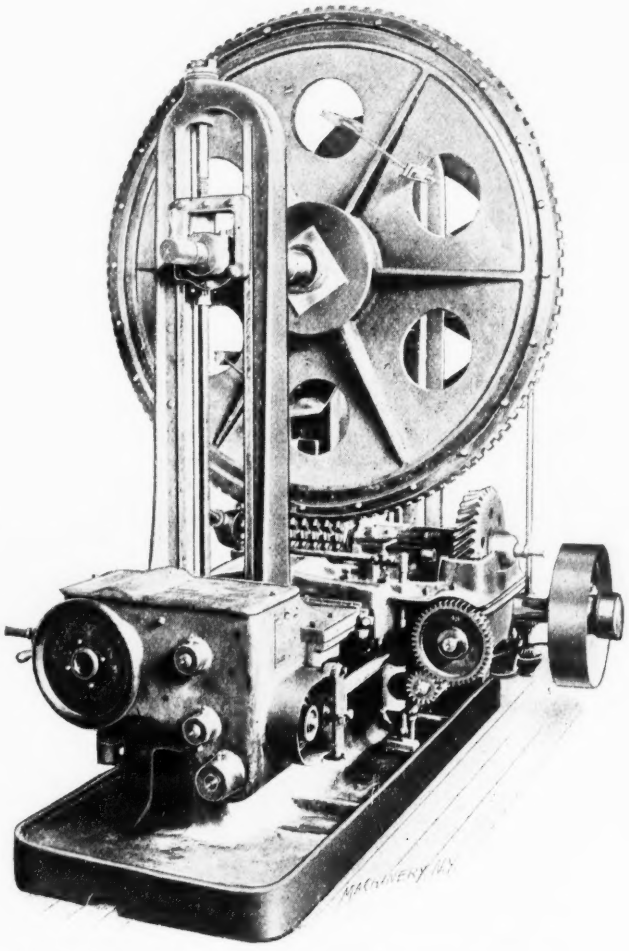


Fig. 117. Gould & Eberhardt Gear-cutting Machine arranged for Hobbing Worm-wheels.

mechanism, it would still follow the thread of the imaginary worm, even if the latter, with the spindle- and work-driving mechanism, were in motion.

Another method consists in combining in the work, also by differential gearing, a rotation due to the revolving of the cutter with a rotation due to the axial feed of the cutter bar. That this produces the same effect as the previous arrangement will also be understood from Fig. 119.

First, let the rotation of the cutter be arrested. If the cutter-bar with a worm mounted on it, such as shown by the dotted lines, be now fed axially in the direction of the arrow, the positive connections between the feed and the work spindle through the change gearing and the differential gearing, will cause the work to rotate uniformly with it. If the feed is arrested after a time, and the bar is started revolving, the imaginary worm mounted on it will still be kept in proper mesh with the work, owing to the change gear connections between the cutter-bar and the work spindle, acting through the differential gearing. As we have previously explained, the office of the differential gearing is to combine in the work the rotation due to the feeding and that due to the rotation of the worm, in such a way that they can take place simultaneously as well as separately; so that it will be seen that if the connections are properly made, the worm may be fed endwise and revolved at the same time, always keeping in perfect step with the work.

Now, the imaginary worm and the fly-tool are both firmly fixed to the cutter bar, so that the fly-tool must always follow the movements of the imaginary worm. Being set to coincide with the outlines of the worm thread at the start, it must always coincide with those outlines, and since the worm is never out of step with the work, the fly-tool will never be

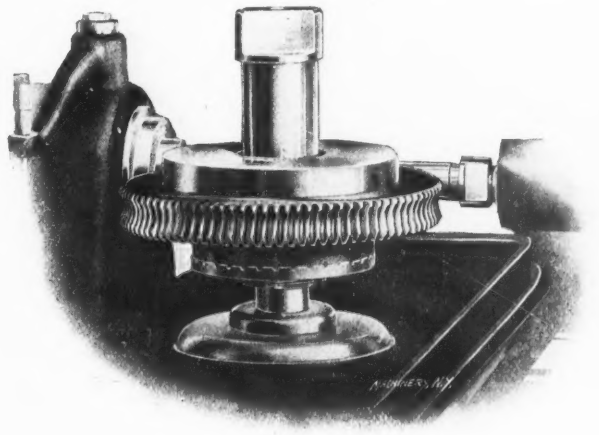


Fig. 118. Worm-wheel being finished in Grant-Lees Gear-hobbing Machine.

either. It will thus be seen that it will always follow the helical path of the dotted lines in Fig. 119, in moving, for instance, from T_1 to T_3. Revolving in the position T_3, T_4, T_2, etc., the work, as shown in the dotted lines of T_2, will always be in proper relation with the fly-tool, as it is with the imaginary worm.

With this arrangement, if the change gearing connecting the driving mechanism of the cutter-bar and the work were disconnected while the bar was fed through from left to right, the rotary motion given by the connection of the feed of the bar with the work would shape one tooth. If, on the other hand, the gearing connecting the feed of the bar with the rotation of the work were disconnected while the connections between the drive of the bar and the work were in operation, the cutter would partially shape each tooth of the work. By combining the two movements in the differential gearing, the cutter perfectly forms all the teeth.

Machines for Cutting Worm-wheels by the Fly-tool Method.

The first machine we show employing the progressive fly-tool principle was also, so far as the writer is aware, the first

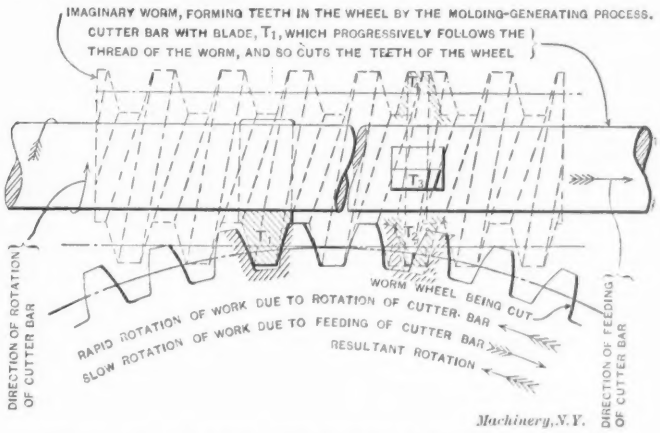

IMAGINARY WORM, FORMING TEETH IN THE WHEEL BY THE MOLDING-GENERATING PROCESS.
CUTTER BAR WITH BLADE, T1, WHICH PROGRESSIVELY FOLLOWS THE THREAD OF THE WORM, AND SO CUTS THE TEETH OF THE WHEEL
WORM WHEEL BEING CUT
RAPID ROTATION OF WORK DUE TO ROTATION OF CUTTER-BAR
SLOW ROTATION OF WORK DUE TO FEEDING OF CUTTER BAR
RESULTANT ROTATION
DIRECTION OF ROTATION OF CUTTER BAR
DIRECTION OF FEEDING OF CUTTER BAR
Machinery, N.Y.

Fig. 119. Diagram showing the Principle of the Fly-tool Method of cutting the Teeth of Worm-wheels.

commercial machine of the kind. It is the product of the Nya Aktiebolaget Atlas, of Stockholm, Sweden. This is the same machine that we have previously described, and illustrated in Fig. 34; in Figs. 120 and 121 it is shown set up for cutting worm-wheels. The machine is driven from cone pulley *A*. Shaft *B*, to which this pulley is keyed, is connected by the bevel gearing shown with vertical splined shaft *C*, from which, through change gears *D* and driving gear *E*, the fly-cutter arbor *F* is driven. Gearing in case *G* connects shaft *C* with horizontal driving shaft *H*, which rotates the worm

for revolving the work table and the work. Change gears *D* thus furnish the means for rotating the work and the hob in the proper ratio with each other.

Pulley *J* is connected inside the frame to the feed shaft *K*, seen in the end view. *K* is connected through change gears *L* and *M* with shaft *N*, which also leads to casing *G*. Change gears *M* are not altered for cutting worm gearing, being employed for indexing in the case of spiral and spur gears. Change gears *L*, however, are set to the lead of the worm. Shaft *K*, besides being thus connected to shaft *N*, drives, through suitable shafts and gearing, feed screw *O*, by means of which is traversed on the cross rail the slide on which the fly-cutter arbor is carried, this arbor *F* being driven by a spline in the hub of gear-wheel *E*. Casing *G* contains differential gearing which combines the movements of shafts *C* and *N* in shaft *H*. It will thus be seen that by setting change gears *D* the work will be given a rotation to correspond with the ratio of the number of threads in the worm and the number of teeth in the gear, while by setting change gears *L* properly, the work will be rotated in unison with the axial feeding of the cutter-bar as in moving T_1 to T_2 in Fig. 119, thus filling the necessary conditions.

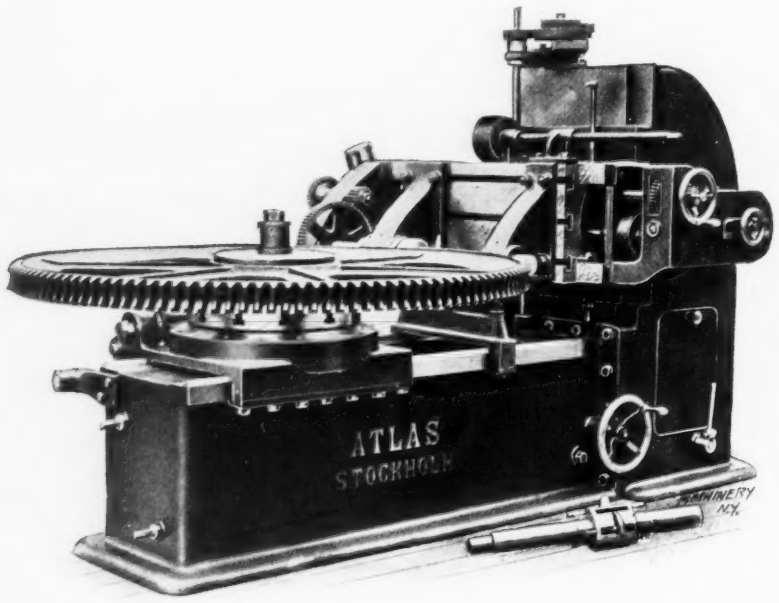


Fig. 120. The Atlas Gear-cutting Machine, also shown in Fig. 34, arranged for Cutting the Teeth of Worm-wheels by the Fly-tool Process. Note Quadruple Fly-tool on the Floor opposite the Machine.

Aside from the ingenuity of the mechanical movements thus described, this well-known machine is carefully planned throughout, being of pleasing design and simple construction, considering the variety of work it is intended to perform. This work includes, as we have before mentioned, the cutting of spiral, internal, spur and worm gears.

Another machine of the same class (which we have previously described in MACHINERY*) is shown in Figs. 122 and 123, built by Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J. In this tool the work table is stationary as to its position on the bed, while the column carrying the cutter slide is adjusted in and out to suit the diameter of the work, thus reversing the conditions that obtain with the Atlas machine in Fig. 120. Another change in the construction is in the provision for the axial feeding of the cutter-bar. In the case of this machine, instead of supporting the cutter on a slide which is fed along the cross-rail, as in Fig. 120, the supports for the bar are stationary, the latter being fed through them by a sliding head (*P* in Fig. 123) at the outer end of the cross slide. By this means, the cutter-bar is brought much closer to the face of the column, and one of the sliding joints between it and the column is eliminated. Both of these features tend toward rigidity and consequent increase in output.

The mechanism will be easily understood from a study of the diagrams of Fig. 123. Driving pulley *A* is connected by gears *B* (which are changed to give the desired spindle speeds) with shaft *D*, which, by means of bevel gears *C*, in turn drives vertical splined shaft *W*, by means of which connection is made with the worm and worm-wheel *E* which drives the cutter-bar. Shaft *D* is continued along the bed to change gears *F*, which are changed to give the proper ratio between the rotation of the cutter and of the work. These gears drive one of the members of the differential gearing *X*.

Feed cone *J* is connected by gearing *K* with shaft *Q*. The latter, through two sets of worm gearing and vertical shaft *L*, drives horizontal shaft *M* on the cross rail. From here, through gears *N*, the movement is led to feed-screw *O* by which head *P* is traversed to feed the cutter bar axially. *Q* is also connected by change gears *R* and the worm gearing shown with differential gearing *X*; gears *R* are selected to agree with the pitch diameter of the work. In differential gearing *X*, motions from shafts *D* and *Q* are combined to rotate the work table and the work in the same way as in the

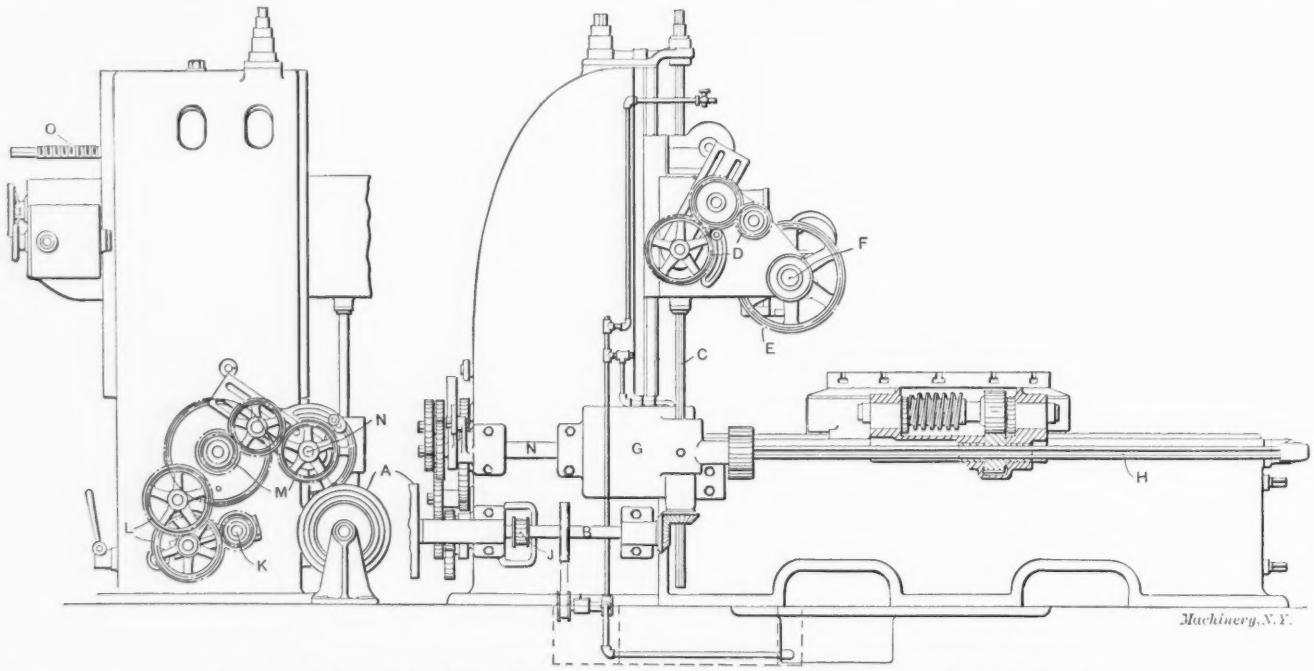


Fig. 121. Diagram of the Driving Connections of the Atlas Gear-cutting Machine shown in Fig. 120.

*See article "Generating a Large Worm-Wheel" in the October, 1907, issue of MACHINERY, Engineering edition; and "New Tools of the Month" in the December, 1904, issue of MACHINERY.

Atlas machine, and as required in Fig. 119. For small blanks, the spindle is rotated through spur gearing at *H*. For heavy work, however, a driving pinion is directly connected with

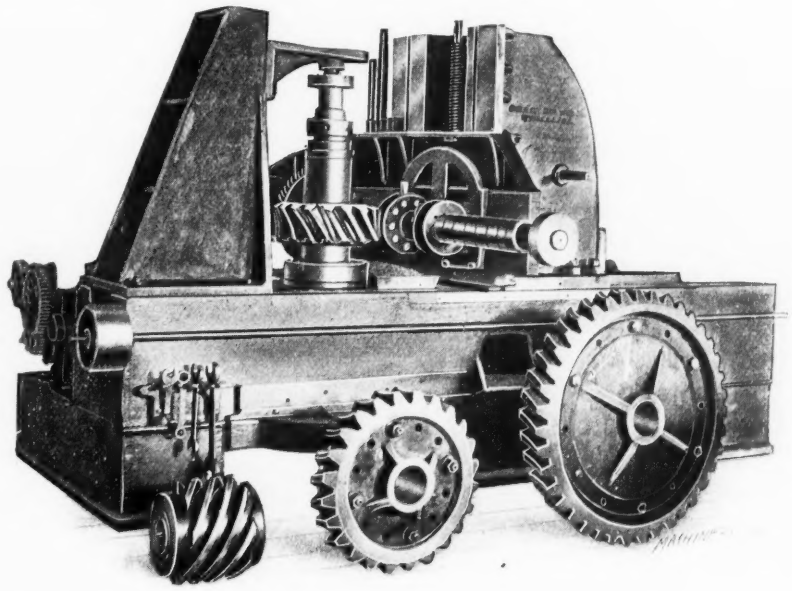


Fig. 122. Eberhardt Bros. Fly-tool Worm-wheel-cutting Machine, with Samples of Work.

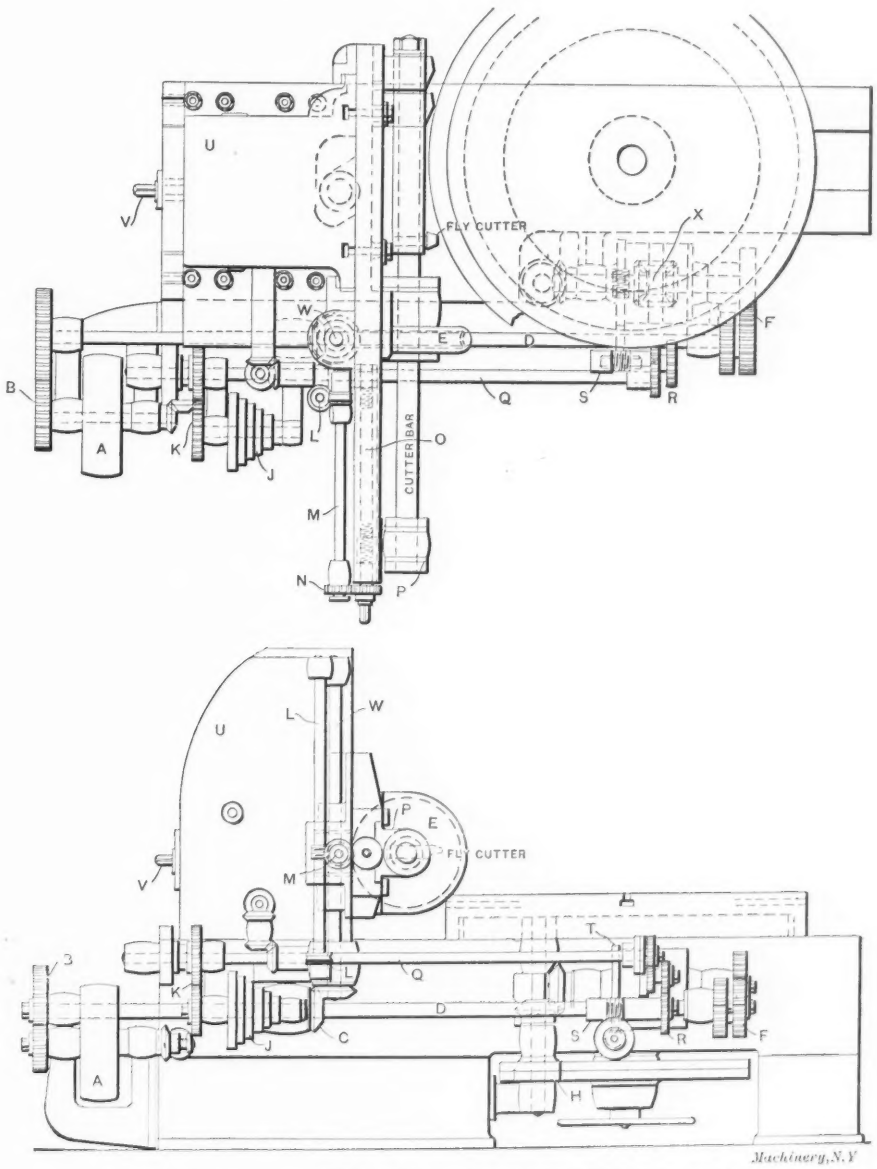
teeth on the inner rim of the work table, so that a very powerful drive is obtained.

This machine can also be arranged to use the ordinary cylindrical hob, in which case the feed of head *P* is thrown out, and the column *U* is fed inward on the bed by means of screw *V*, so that the hob enters the blank in the same manner as for the machines in Figs. 113 to 118.

In Figs. 124 and 125 are shown halftone and line engravings of a fly-tool gear-hobbing machine built by Henry Wallwork, Ltd., Redbank, Manchester, England. The action of the fly-cutter on the work is identical with that in the machines previously described. The work is carried by the face-plate and vertical spindle *A*, while the fly-tool *B* is mounted in the cutter spindle *C*. This latter is supported in slide *D* which is adjustable on the top of the bed for the diameter of the work, and is fed by screw *E*. The fly-tool starts in at one side of the work and feeds longitudinally through it, the work and tool revolving together, as in previous cases. A peculiarity of this machine, however, is that no differential mechanism of any kind is employed. The way in which this is avoided may be explained thus:

Suppose that in the Eberhardt machine in Fig. 123, the fly-cutter be engaged in hobbing a worm-wheel of 100 teeth, to mesh with a single threaded worm. If, then, the fly-cutter makes 100 revolutions per minute, the worm will make one revolution per minute. If now the cutter spindle be fed longitudinally with a certain definite feed, the differential mechanism will modify the rate of rotation of the worm, making it slightly more or slightly less than one revolution per minute, depending on the rate of the feed, and its direction as compared with the direction of rotation of the work. We may say, then, that if the cutter revolves at a certain number of revolutions per minute and feeds at a certain fraction of an inch per minute, the work will rotate at a certain number or fraction of a number of revolutions per minute. Where the gearing required with the Eberhardt machine would give a ratio of 100 to 1 between the hob and the work, as modified by the feed this ratio might be 100.0073 to 1, for instance. It will thus be seen that since these conditions remain constant until the work is completed, the differential mechanism may be dispensed with entirely, if we select the change gears connecting the hob and the work to agree with the new rate of turning of the work, as modified by the feeding of the hob.

This is what is done in the Wallwork machine. The driving shaft *F* is connected with the driving cone *G* either directly or through back gears, as may be required. This shaft, through worm-wheel *H* and change gears shown in Fig. 124, drives feed-screw *E*. It also has keyed to it worm *J*, meshing with the indexing worm-wheel by which the work on the vertical spindle *A* is rotated. At the extreme right in Fig. 125 this driving shaft is connected with cutter spindle *C* by change gears *K*, mounted on a sector which is provided with a worm-wheel adjustment at *L* for setting it, owing to its great weight. It will thus be seen that the feed, the work, and the cutter-bar are all connected by positive gearing. For setting up the machine, suitable change gears for connecting screw *E* with the driving-shaft mechanism are used to give the desired rate of feed. Then change gears *K* are selected to give the proper ratio between the work spindle *A* and cutter spindle *C*, as determined by the ratio between the number of threads in



Machinery, N.Y.

Fig. 123. Diagram of the Driving Connections of Eberhardt Bros. Machine.

the worm and the number of teeth in the worm-wheel, modified (as explained) by the rate of feed. These change gears K are calculated by a formula which is somewhat puzzling to derive, but not difficult to use.

This arrangement would seem to possess both advantages and disadvantages as compared with the differential scheme. It results in a much simpler mechanism, but it makes it impossible to change the feed without changing, as well, the gearing connecting the work spindle and the hob, so that changes of feed are not easily made.

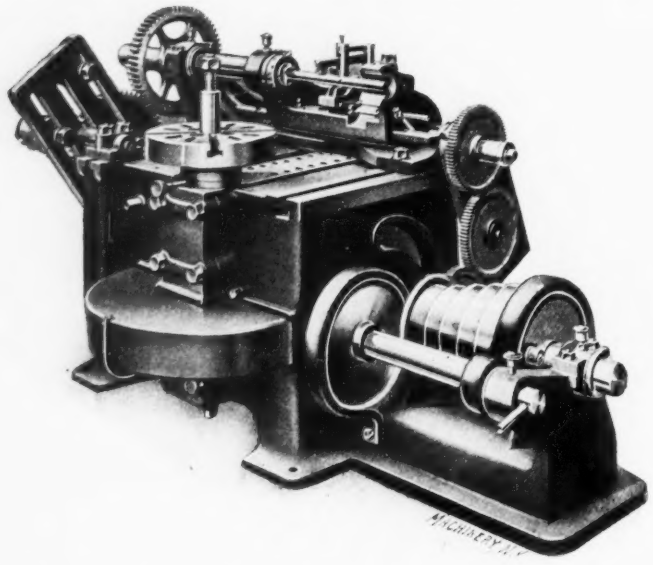


Fig. 124. The Wallwork Machine, which cuts the Teeth of Worm-wheels with a Fly-tool without using Differential Gearing.

Cutting Wheels for Multiple Threaded Worm by the Fly-tool Process.

The method of cutting multiple threaded worms was not described in discussing the principle of the fly-tool process. At the base of the machine in Fig. 120 is shown a form of tool which may be used for cutting wheels to match with multiple threaded worms. In this case, in which a quadruple thread has to be provided for, a cutter head is provided in which four blades are carried, spaced equidistant. The feeding through of these four blades simultaneously finishes the worm-wheel complete in one operation. An alternative method would be to index the cutter bar with relation to its driving gear, giving it three positions for a triple-threaded worm, four for quadruple threads, etc. This could be done by a notched index plate and locking bolt, or by unmeshing the gearing from engagement at some point in the driving train, and shifting it the required number of teeth before re-engaging it.

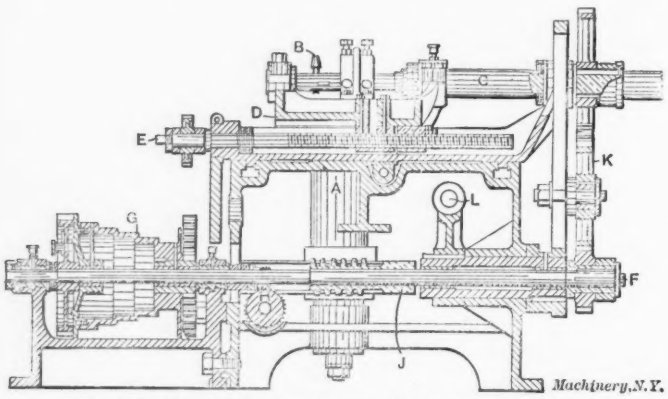


Fig. 125. Vertical Section through Wallwork Worm-wheel Generating Machine.

The Tapered Hob for Cutting Worm-wheels, and Machines for using it.

In Fig. 126 is shown a gear-hobbing machine built by J. E. Reinecker, of Chemnitz-Gablenz, Germany. This machine has the movements required for performing the work of the Atlas and Eberhardt machines, since it combines in the rotation of the work a movement due to the longitudinal feed of the cutter spindle and a movement due to the rotation of the cutter spindle. It is ordinarily used, however, with a hob instead of a fly-cutter, the hob being of the special form shown in Fig. 127. This hob, as shown, is tapered. It is placed on the cutter spindle and fed axially past the work in the same way that the fly-tools in the previous cases are fed. The combined movements cause the hob to follow spirally in the path of the thread of the imaginary rotating worm. The small end of the hob first commences to work and as the cutter spindle is fed forward, the cut is taken successively on larger and larger diameters until finally, when the tool has passed clear through, the full-sized teeth at the rear end of the hob complete the work. The machine is practically identical with the universal gear-cutter by the same maker, previously shown in Figs. 85 and 86, it being adapted, as there shown, to cutting worms by the same process. The differential mechanism used is the same as in Fig. 86, the axial feed of the cutter spindle being applied to shaft M, while the rotative movement of the cutter spindle is connected with shaft H, the two being combined in gears J, L, and N to rotate the indexing wheel G.

The original machine for this purpose, built by Mr. Reinecker, employed a different form of combining or differential movement. It is shown diagrammatically in Fig. 128. In this case, the tapered hob is connected by change gearing with the worm driving the indexing wheel, as before. The worm, however, is mounted on a slide, allowing it a considerable range of axial movement. This axial movement is controlled by a screw and nut, as shown. This screw is connected by change gearing with the screw by which the taper hob is fed. It will thus be seen that the feeding of the hob rotates the work by shifting the index worm lengthwise, while the rotating of the hob rotates the work through the rotation of the index worm and worm-gear. The two movements are independent of each other, but are combined with the same effect as produced by the "jack-in-the-box" differential gearing previously described. With this arrangement, the ratio of table movement and lengthwise worm movement should be proportioned in the ratio of the pitch diameters of the worm-wheel being cut, and the index worm-wheel. The reason for abandoning this construction was doubtless its limited range of movement, which, though enough for the hobbing of worm-wheels, was not enough (when applied to the universal gear-cutting machine) for cutting spiral pinions of great helix angle.

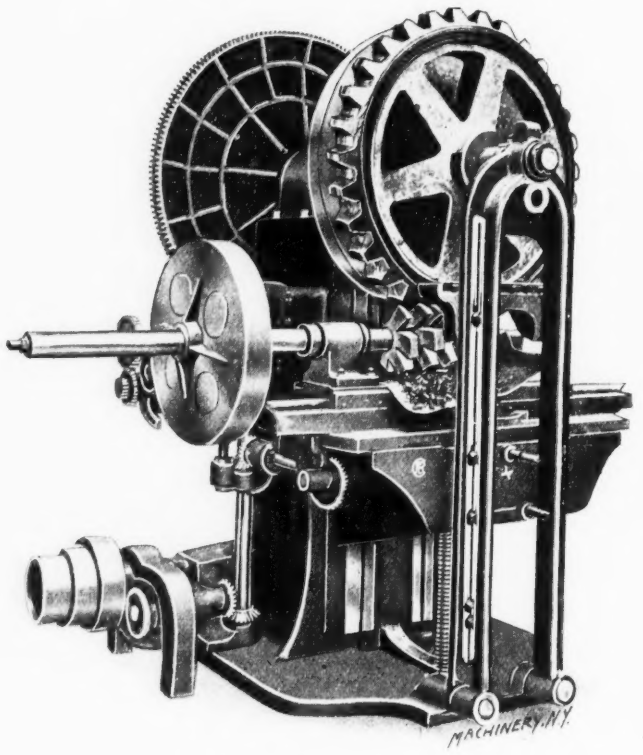


Fig. 126. Machine for Generating Worm-wheels with a Taper Hob; built by J. E. Reinecker, Germany.

The tapered form of hob and the method of using it are of course as applicable to the Atlas, Eberhardt, and Wallwork machines as to the one we have just been describing, and it has doubtless been used on all of them.

The Various Methods Compared.

Each of the various methods of cutting worm-wheel teeth which we have described has its field of usefulness. Gashing, as we have seen, is applicable either to cheap, rough-and-ready work on the one hand or, on the other hand, to the cutting of worm-wheels which are not required to transmit a great amount of power, but in which the highest degree of accuracy

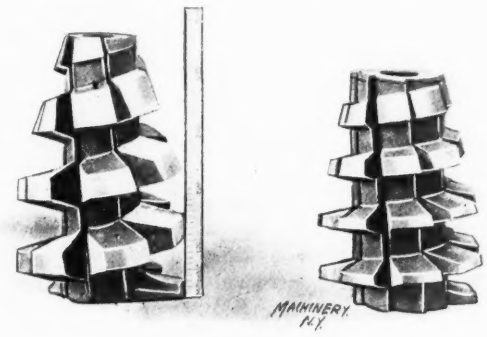


Fig. 127. Style of Hob used for Machine shown in Fig. 126.

is required. The process of hobbing previously gashed blanks requires the least degree of specialization in the machinery used, the ordinary milling machine having all the movements and adjustments required. This process is perhaps the one followed in most shops in making worm gearing of small size. The arrangement (such as shown in Figs. 114 to 118) in which the work and the hob are positively geared together so that previous gashing is not required, is quicker than the last mentioned method, but requires special machines or attachments. The fly-tool method requires a still more elaborate machine, but is the least expensive of all in the matter of cutting tools. A large hob is an exceedingly costly appliance, and raises the cost of production to an alarming degree, particularly when but one worm-wheel has to be cut. The use of a simple fly-cutter, which may be ground accurately to size after hardening so that all inaccuracies are avoided, is thus the cheapest as well as the most accurate means of cutting a large worm-wheel. Where many large wheels of the same size are to be cut, the taper hob method would seem to be a most satisfactory one. A high degree of accuracy could be maintained, as the full size teeth at the back end of the hob do not come into play until the finishing cut is reached,

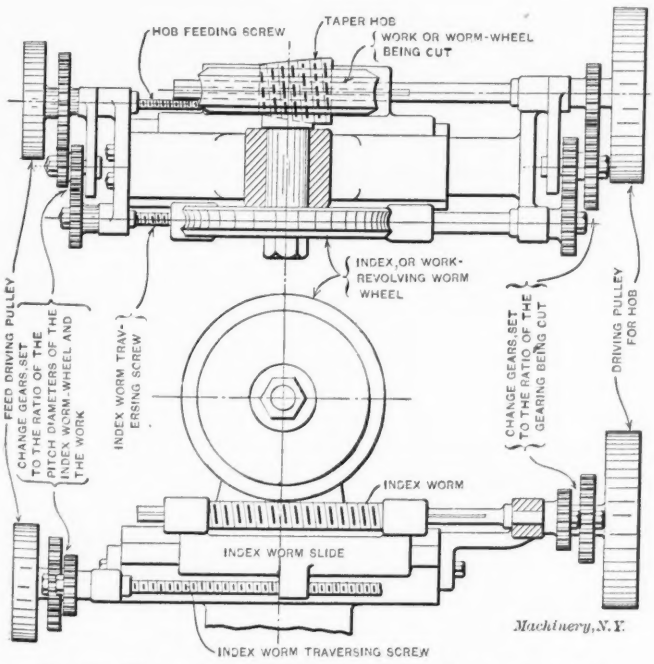

HOB FEEDING SCREW
TAPER HOB
WORK OR WORM-WHEEL BEING CUT
INDEX, OR WORK-REVOLVING WORM WHEEL
FEED DRIVING PULLEY
CHANGE GEARS, SET TO THE RATIO OF THE PITCH DIAMETERS OF THE INDEX WORM-WHEEL AND THE WORK
INDEX WORM TRAVERSING SCREW
CHANGE GEARS, SET TO THE RATIO OF THE GEARING BEING CUT
DRIVING PULLEY FOR HOB
INDEX WORM
INDEX WORM SLIDE
INDEX WORM TRAVERSING SCREW
Machinery, N.Y.

Fig. 128. Diagram of Original Form of Mechanism for Generating Worm-wheels with Taper Hob.

so that they tend to preserve their shape indefinitely. Another item that tends to accuracy in this method of hobbing is the fact that the distance between the work arbor and the cutter spindle, is fixed at exactly the distance between the axis of the worm and the worm-wheel in the finished gearing. This is a refinement of greater importance than is usually realized, and one that is not always looked out for in hobbing operations in which the cutter spindle is fed in toward the work. Hobbing by this method is, of course, more rapid than by the fly-tool process employed on the same machines, though the latter is not a tedious operation by any means, as a solidly supported and powerfully driven tool can be given a heavy feed, taking off chips of respectable thickness.

The methods followed in cutting the other member of this form of gearing, the worm, have already been described in connection with the machine for cutting helical and herring-bone gears.

The Manufacture of the Hindley Worm Gearing.

A form of gearing which has come into extensive use of late years in elevator service and other applications in which considerable power has to be transmitted, is shown in Fig.

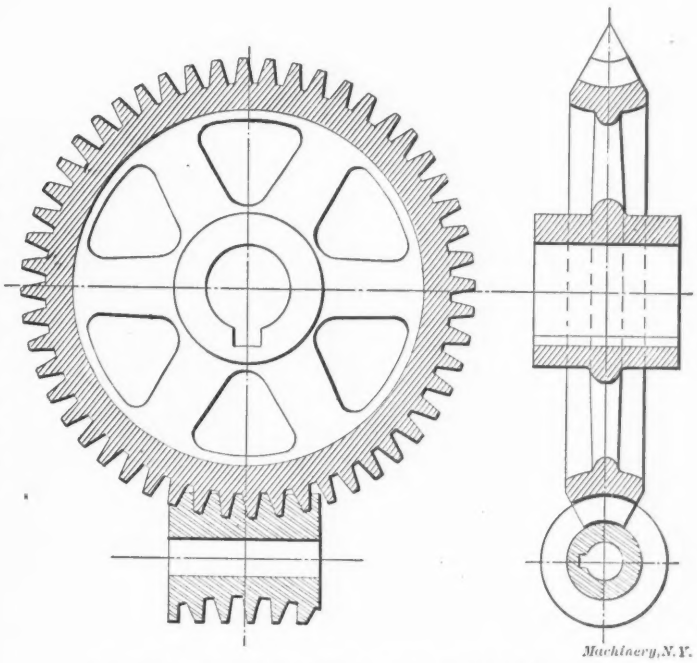


Fig. 129. The Form of Globoid Gearing generally known as Hindley Worm Gearing.

129. This is commonly known as the Hindley "worm" gearing, though it is not worm gearing at all, being entirely different in its action. It should properly be classed as "globoid" gearing, a term which, so far as the writer knows, was first employed by Prof. Reuleaux. The characteristic feature of its action is the fact that contact takes place on or near the axial plane of the worm, as shown in the engraving. Unlike other forms of gearing, neither member of this pair has a pitch line or a pitch diameter. The form of gearing is an old one, but it has only recently come into practical use.

It is often stated that this style of gearing gives surface contact, but this statement can scarcely be true. The impression doubtless arose from a consideration of sections on the two planes shown in Fig. 129, in which it may be seen that the wheel is curved to fit the worm, and the worm is curved to fit the wheel, thus giving the appearance of intimate contact over the whole face of the tooth. It is probable that the surfaces more nearly match than in ordinary worm gearing, giving a nearer approach to surface contact.

Any positively operated worm-wheel hobbing attachment or machine, such as shown in Figs. 114 to 118, may be used. The manufacture begins with the cutting of the worm, which is effected as shown in Fig. 130. The blank is mounted on the spindle of the machine ordinarily occupied by the hob, while a large diameter disk provided with cutting tools clamped to its face is mounted in place to represent the worm-wheel. The cutting tools mounted on this disk each represent a tooth of

the wheel, being of the same shape and cutting on the same diameter. They are clamped to the face of the disk in such a way that the whole arrangement represents accurately a central section of the worm-wheel, of which (in this particular case) only every other tooth is used. This cutter and the worm to be cut are geared together, and slowly fed toward each other as when hobbing worm-wheels. The teeth, cutting deeper and deeper into the blank, finally form it into the characteristic "hour-glass" shape of the Hindley worm.

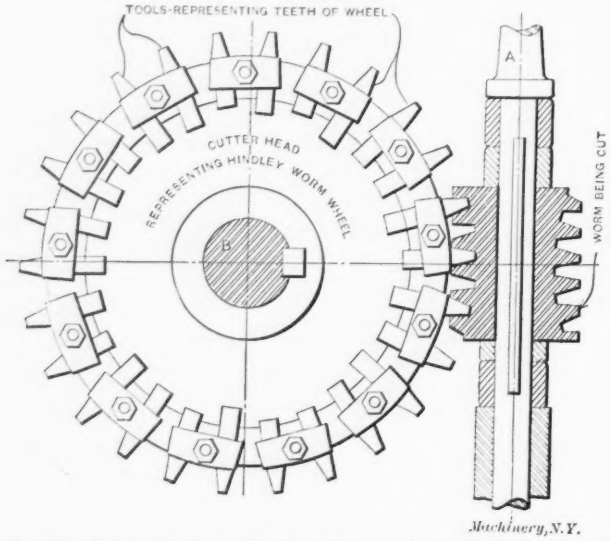


Fig. 130. Method of Cutting Hindley Worm with Rotary Cutter having Teeth corresponding with those of the Wheel.

In cutting the wheel, the process is reversed, as shown in Fig. 131. A hob cut in the same way as the worm in Fig. 130, but with its teeth relieved, is fed into the wheel blank and cuts the teeth in a way exactly identical with the method followed in hobbing worm-wheels, the only difference in the process being the difference in the shape of the hob and in the shape of the teeth produced.

The actual operation of hobbing the worm and the gear is a little more complicated in practice than is indicated here, as certain corrections have to be made for interference that require cutting the worm first with a cutter head of the same diameter as the wheel in the way we have shown, and a second time with a head of somewhat larger diameter. The necessity for this it would take too long to explain in an article which deals particularly with machines and tools, rather than with the theory of gearing.

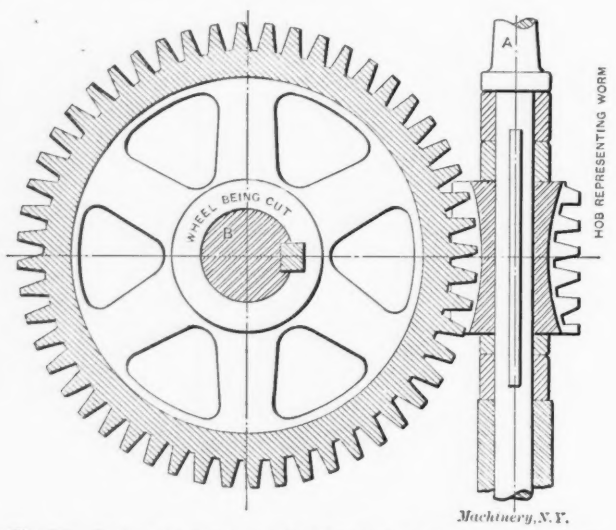


Fig. 131. Cutting the Teeth of the Wheel with a Hob corresponding with the Worm.

This concludes a discussion of machines and methods for cutting the teeth of worm-wheels. The next installment will deal with bevel gear cutting processes.

On page 592 of the May installment of the series of articles on gear-cutting machinery, a record was given for hobbing spur gear teeth in which it was stated that the time for cutting a cast iron wheel of 84 teeth, 4 inches circular pitch and 2½ inches face, was 1 hour and 21 minutes. There was an error in this statement in that the pitch should have been given as 4 *diametral*. This, of course, makes the achievement somewhat less spectacular.

It should also be noted that a misprint occurs in the title of Fig. 103. The word "Pfauder" should read "Pfauter."

* * *

RELIABILTY OF MOTOR DRIVES FOR MACHINE TOOLS.

The reliability of the individual motor drive for machine tools is indicated by an item in the *American Engineer and Railroad Journal*. Probably a greater proportion of the machine tools in the McKees Rocks shops of the Pittsburg & Lake Erie Railroad are equipped with individual motor drives than in any other railroad shop in this country. During the year 1907 the average delay to tools, due to motor troubles, was about seventeen minutes. There are 84 motors in use for driving machine tools, and during the year there were only 93 delays, or an average of 1.1 per motor per year. The longest delay was 1¼ hour. The total time of all delays during working time was 26½ hours. Assuming an average rate of 27½ cents per hour for the machinist's wages and a surcharge on each machine of 50 cents per hour, would bring the total loss due to delays to only about $20.00 for the year. These delays include all time lost due to the failure of electrical apparatus at the machine. As a matter of fact the greater part of the time lost was due to trouble with the controllers and not with the motors themselves. When it is considered that these motors operate on the multiple voltage system, the controllers furnishing 21 speed steps over a range of about 3 to 1, it is remarkable that so little trouble occurred, especially as these controllers were among the first of this type that were placed in operation.

* * *

VACUUM BRAKE EXPERIMENTS.

Extensive experiments have been carried out on the Austrian government railways with automatic vacuum brakes on freight trains. A long train, composed of 70 cars loaded with coal and weighing 44,000 pounds each, was fitted with automatic brakes. Numerous trials were carried out with this train on lines having different road conditions, and, in order to ascertain the effect on steep grades, the trials were repeated on a line with gradients of from 3 to 3.1 per cent. In this experiment the train was composed of 70 freight cars and 5 passenger cars, interspersed for observation purposes. Twenty-nine of the total 75 cars carried load, and 46 carried no load. The weight of the train including locomotive and tender amounted to 1,201.7 metric tons (1,322 short tons) and the total length of the train was 2,620 feet, or nearly half a mile. To enable observations and simultaneous readings to be taken, the locomotive and each of the 5 passenger cars were fitted with telephones and measuring apparatus. The results are said to have been very satisfactory, and will form the subject of a publication shortly to be issued by the Austrian government railways. Considering the length of the train, the brake valve on the last car came in action very rapidly, only 2.2 seconds being required for the brakes to be applied on the last car after they had been applied on the locomotive. This corresponds to a brake speed of 1,191 feet per second.

* * *

The old, time-honored division of the study of mathematics into algebra, analytic geometry, and differential and integral calculus has been discarded by the Massachusetts Institute of Technology, and the whole field of the science of mathematics will be covered simultaneously. The principles of each of the old subjects are to be introduced, and all subjects developed, together. This change has been deemed advisable in order to give the students a better grasp of mathematics as a whole, and an adequate idea of the interdependence of the various branches, and also in order to accustom the students to the use of judgment in the selection of methods best adapted to the problem in hand. Undoubtedly this early introduction of calculus and analytic geometry will be found very advantageous. The whole system is intended to develop a more thorough study of mathematical principles and to do away with that kind of mathematical study which consists in mere mechanical training of the use of formulas.

MAKING WATCH PARTS IN THE COMMERCIAL AUTOMATIC SCREW MACHINE.*

Watchmaking by automatic machinery is essentially an American development. Previous to the inaguration of the industry in Waltham, Mass., Switzerland held the lead in the manufacture of watches on a large scale. The hand processes there followed are the result of long experience and careful study, and the work is highly organized so far as the division of labor is concerned, separate workmen specializing on single operations, which they repeat day after day, as long as they live and work. Swiss watches are not hand-made in the sense in which we apply that term to custom-made footwear, for instance. Of course, lathes, presses, gear- and pinion-cutters and other power-operated

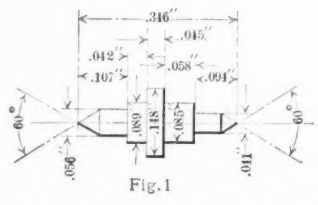


Fig. 1

Fig. 1. Blank for Watch Pinion made by Forming, from Tool Steel Stock.

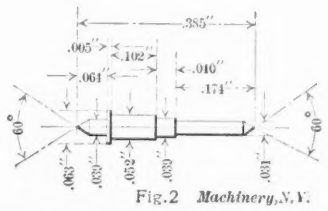


Fig. 2 *Machinery, N.Y.*

Fig. 2. Blank for Watch Wheel Staff made by Turning, from Tool Steel Stock.

machines are used in the various operations required. These tools have, however, been largely operated by hand in the same way that ordinary engine lathes are operated, as distinguished from the mechanically controlled movements of the automatic gear-cutter or screw machine.

In American watchmaking practice the automatic principle has been developed to an extent that is little short of marvelous, the parts not only having complicated operations performed on them in single machines, but even being transferred from one machine to another automatically, through a long series of operations. The various manufacturers of

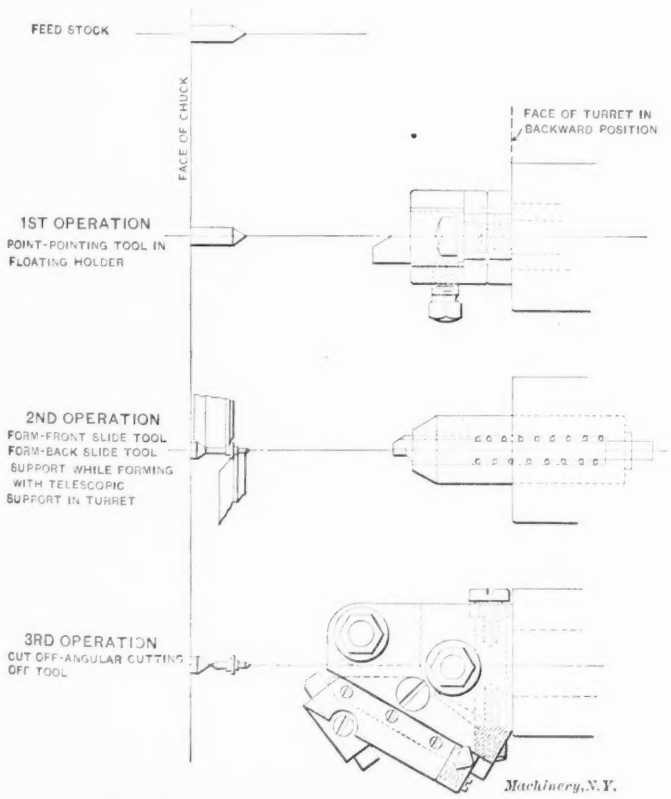


Fig. 3. Tools Used and Order of Operations Followed in making the Pinion Blank shown in Fig. 1.

watches in this country have, as a rule, each developed their own machinery, employing competent designers and mechanics for the purpose.

A notable exception to this general rule, however, may be instanced in the case of the automatic screw machine made by the Brown & Sharpe Mfg. Co., of Providence, R. I., which has been invading this highly specialized field of watch making, and has been very successful in the work it has been called on to perform. Curiously enough, considerable favor has been met with by this machine in the Swiss watchmaking field, committed though it is by years of precedent, to the use of the hand-operated machine. This interest in the American automatic screw machine may therefore be taken as an evidence of the inroads of American ingenuity on Continental conservatism.

The Work for which the Machine is Used.

The particular work for which this tool has been applied is in the turning of the larger pinion blanks and staffs (the slender shafts or spindles on which gears and pinions are mounted). These parts have to be made, it goes without saying, with a high degree of accuracy, both as to their dimensions and as to their concentricity, or the trueness with which they run on centers. Accuracy of dimension is largely a matter of careful, close fitting of the machine, so as to have all the slides and their movements accurately aligned and moving freely, yet with the smallest possible allowance for lubrication. This matter is carefully looked out for in the tool under consideration, though it is probable that for the most minute of the minute work used in watches, it would be impossible to make the fitting close enough on so large a machine. The space required for oil for the journals, for instance, would involve inaccuracy which could not be permitted. For work, however, of the size shown in Figs. 1 and 2, this machine has been found eminently satisfactory. We will illustrate and describe the methods and tools used in producing these pieces, these matters being fully as important as the design and workmanship of the machine in producing the accurate results required.

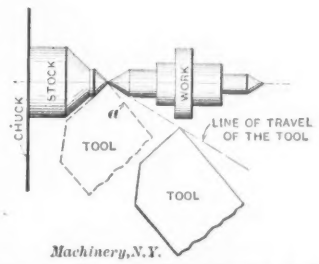


Fig. 4. The Cone Point Turning and Cutting-off Operation.

Tools and Operations for Making a Pinion Blank.

We will first follow the tools and operations used in making the part shown in Fig. 1. This is one of the larger pinion blanks used in a Swiss watch. In making it by the old-fashioned methods, a blank is cut off and formed at each end

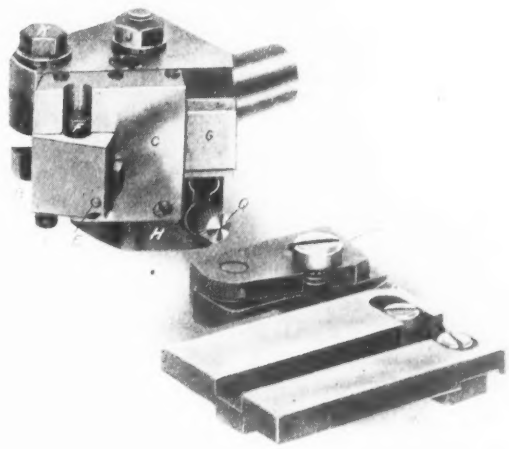


Fig. 5. Cone Point Turning and Cutting-off Tool for Pinion Blanks and Staffs, and the Pusher by which it is operated from the Cross Slide.

with the cone points shown, which are supported in female centers in the lathe, where successive cuts are taken to bring it to the required dimensions, the same as would be done for much larger work in the engine lathe. This operation is practically duplicated in the automatic screw machine, so far as turning on centers is concerned.

The order of operations and the tools used for each of them may be followed from Fig. 3, which is a reproduction of the operation sheet furnished to the purchaser of the machine. The first thing that is done is the feeding of the stock. No stop is used for the stock to feed against, the feeding mechanism being accurate enough to always leave a few thousandths of stock for the first operation, which is that of pointing the end of the bar to form the outer cone-shaped pivot

* For a description of this machine see the article published in the September, 1903, issue of MACHINERY, on "Directions for Camming the Brown & Sharpe Automatic Screw Machine."

point of the work. This is done by a tool mounted in a "floating" holder, which may be firmly clamped in the proper position for forming an accurately pointed pivot each time the machine is set up. With this tool the accurate alignment of the turret with the axis of the spindle is not absolutely necessary; in fact, no alignment accurate enough for this purpose could be permanently maintained.

This piece of work is short enough and stiff enough so that it can be turned entirely by circular forming tools mounted in the cross slide. These forming tools are shown at work in the second operation in Fig. 3. The one in the front cross slide turns the two diameters forward of the largest diameter on the work, while the rear cross slide turns the two diameters on the other side of the collar, and rough turns the projecting end of the stock for the cone point of the next part to be made. While these operations are in progress, the outer end of the work is supported in a delicate female center, in a spring plunger held in the turret.

It was stated that this part is practically turned on centers. The significance of this statement will be understood by studying the second operation, and the succeeding or third operation. Since the outer end of the work is supported by the center while the forming is in progress, the diameters thus turned must be true with that center. In the third operation the center at the other end of the work is formed. The forming of this center, as shown in Fig. 4, is done by an operation which has been previously described in MACHINERY (see "Methods of Delicate Turning," in the September, 1907, issue of MACHINERY). The blade follows a diagonal line of travel, so that the center is turned to the right angle. Face *a* is beveled so that it clears the work entirely, and the point is quite sharp. The cutting action is thus entirely on the face of the stock, and the work is not subject to any pressure whatsoever, but remains attached to the stock until the tool has progressed so far that it separates and falls off by its own weight, leaving the point so sharp as to be for all practical purposes a perfect one. We have already seen that the outer center is true with the turning. The center formed in this operation is also true with the turning, as the work is, at this point, so close to the chuck that the operation must be concentric. The outside diameter of the piece is left stock size. This large diameter has the pinion teeth cut in it and runs true enough for all practical purposes.

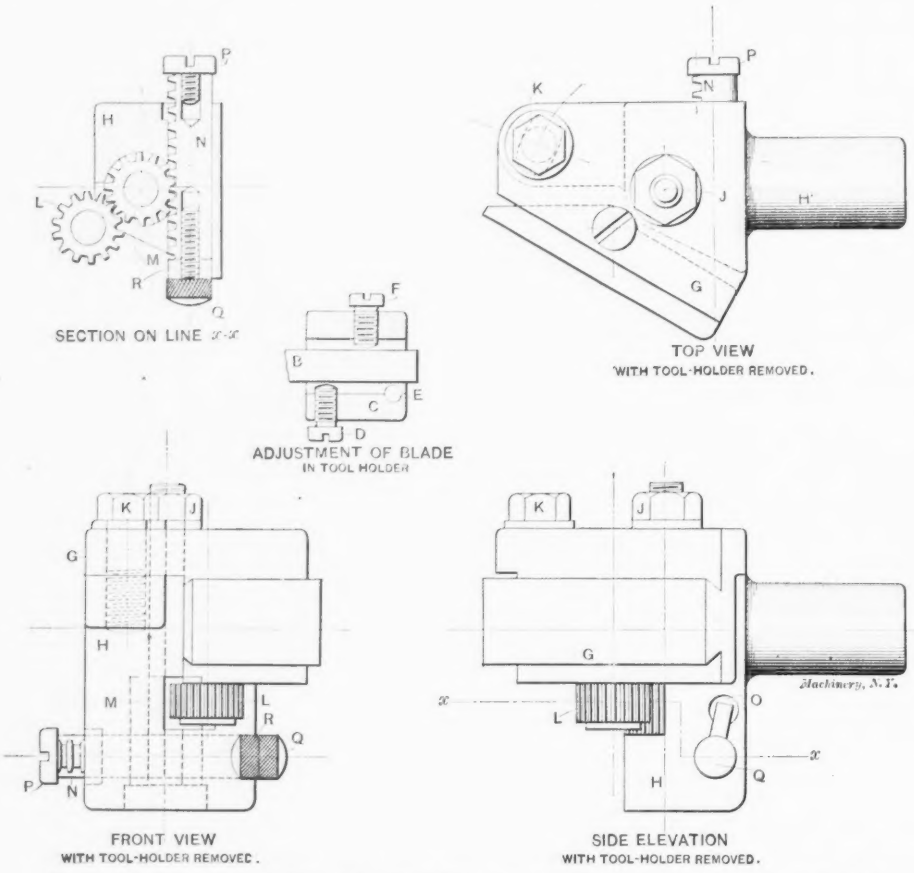


Fig. 6. Details of Construction of the Cone Point Turning and Cutting-off Tool shown in Fig. 5.

Cone Point Turning and Cutting-off Tool.

The construction of the point turning tool can be readily followed from Figs. 5 and 6. The cutting-off blade *B* is held in a slot in tool slide *C* resting on adjusting screw *D* and pin *E*. It is clamped in position by screw *F*; by adjusting screw *D*, the blade is rocked about pivot *E* to bring the point higher or lower as may be required to accurately center it with the axis of the work. Slide *C* is gibbed to a dove-tail guide on slide carrier *G*. This member is pivoted to the body of the tool *H* about the axis of bolt *J*, and is clamped by screw *K* in the proper location to guide the slide *C* in forming the desired angle for the pivot of the work.

Tool slide *C* has attached to it a rack which meshes with the 32-pitch pinion *L*, pivoted to the under side of *G*. Pinion *L* meshes with a similar pinion *M*, pivoted in a hole in the body of the tool about the center of bolt *J*, so that the correct relations between them are preserved whatever the angular adjustment of *G* on *H*. Pinion *M* is lengthened and at its lower extremity meshes with rack teeth cut in the side of plunger *N*. This is best seen in the section on line *x x* in Fig. 6. This plunger, as may be seen in the side elevation, has at its front end a projection extending upward bearing against a plunger *O* in a hole above it, which is pressed outward by a spring. By this means, *N* is normally kept at the outer end of its movement, being limited in this direction by the seating of screw *P* in the recess provided for it in the body *H* of the tool. In this position the tool slide is withdrawn so that the blade clears the work.

The front end of *N* is provided with knurled screw *Q* and lock-nut *R*. These are so located as to be in line with the pusher *S*, attached to the front cross slide of the machine, when the turret has brought the tool to the proper position for cutting off. The cutting off is effected by the movement of the cross slide and pusher *S*. This bears on screw *Q*, presses plunger *N* inward, revolving pinions *M* and *L*, which, in turn, acting on the rack attached to the tool slide, move cutter *B* inward, severing the work from the bar and forming the pivot point, as shown in Fig. 4. The length of the inward travel of the tool is adjusted by screw *Q* and lock-nut *R*. The swiveling adjustment shown for *S* is not needed for this job.

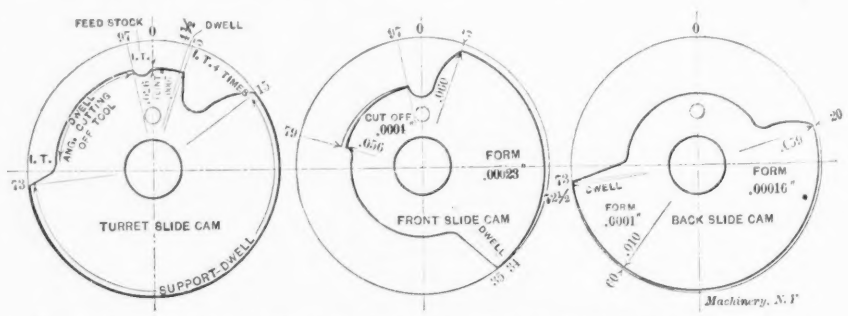


Fig. 7. Turret and Cross Slide Cams used for Making the Pinion Blank shown in Fig. 1.

The operations can be further studied from Figs. 3 and 7. In the latter figure are shown the cams by which the feeding

movements of the machine are effected. As is well known, the Brown & Sharpe automatic screw machine has a front and a back cross slide and a turret slide, each controlled by its own separate plate cam. In Fig. 7 the various radial lines are figured to show their distance from the starting point 0, in hundredths of a circle. The various acting surfaces of a cam have legends on them indicating the operations performed by them. The material used for this pinion blank is tool steel. The spindle revolves 1,320 revolutions per minute, giving a surface speed to the work of about 58 feet per minute, which is suitable for the material used with the heavy flow of oil directed on the cutting edges of the tools. It takes 770 revolutions to make a piece, so that each hundredth of a revolution of the cam represents 7.7 revolutions of the spindle. Knowing this, the various feeds can be

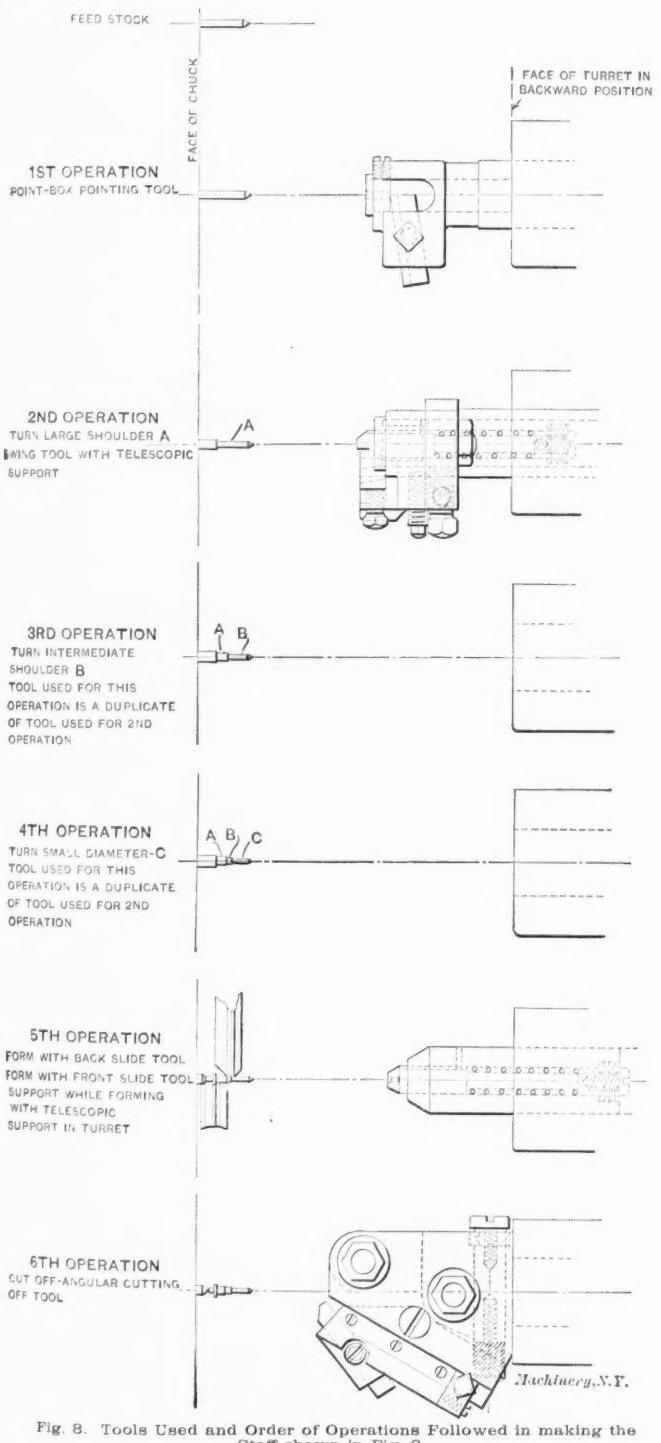

FEED STOCK
FACE OF CHUCK
FACE OF TURRET IN BACKWARD POSITION
1ST OPERATION
POINT-BOX POINTING TOOL
2ND OPERATION
TURN LARGE SHOULDER A
SWING TOOL WITH TELESCOPIC SUPPORT
A
3RD OPERATION
TURN INTERMEDIATE SHOULDER B
TOOL USED FOR THIS OPERATION IS A DUPLICATE OF TOOL USED FOR 2ND OPERATION
A B
4TH OPERATION
TURN SMALL DIAMETER-C
TOOL USED FOR THIS OPERATION IS A DUPLICATE OF TOOL USED FOR 2ND OPERATION
A B C
5TH OPERATION
FORM WITH BACK SLIDE TOOL
FORM WITH FRONT SLIDE TOOL
SUPPORT WHILE FORMING WITH TELESCOPIC SUPPORT IN TURRET
6TH OPERATION
CUT OFF-ANGULAR CUTTING OFF TOOL
Machinery, N.Y.

Fig. 8. Tools Used and Order of Operations Followed in making the Staff shown in Fig. 2.

readily figured out. It will be noticed that on the back slide cam, which takes the wider of the two forming cuts, a finer finishing feed is used between positions 60 and 72½ than for the first portion of the forming between 20 and 60. This is done to produce the finer finish which the finer feed gives. It will also be noticed that in all forming operations, such as those performed by the two cross slides, and by the turret slide in pointing the work in the first operation, the cams are provided with "dwells," or resting places where the periphery of the cam is, for a short space, a portion of the circumference of a circle, so that the slide is allowed to rest at this point while the chip runs out. This produces a smooth final finish. The net production is 900 per day, allowing time for sharpening tools, etc.

Tools and Operations for Making a Watch Staff.

The part shown in Fig. 2 has to be handled somewhat differently from the one we have just been considering. It is much longer and more slender, so that forming it by cross slide tools is out of the question. This part will have to be turned. The order of operations is indicated in Fig. 8.

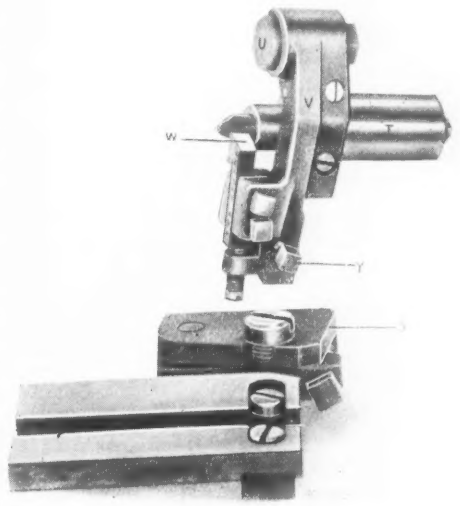


Fig. 9. Swing Tool used for Turning the Staff shown in Fig. 2, and the Pusher by which it is operated from the Cross Slide.

The stock, having been fed to length, is pointed by the turret tool shown in the first operation. In this tool the stock is supported by a bushing while the end is being pointed, the work being too slender to support itself, as in Fig. 3. In the second operation, shoulder *A* is turned. This is done by a "swing tool," which will be described later. The pointed end is supported in a female center, a turning cut is taken over the shoulder of the finished diameter required, the cutting blade is released so that it is not dragged over the work on the return, and then the turret is revolved for the next operation. Operations 3 and 4 are also performed by the same kind of a tool and in the same way, shoulders *B* and *C* being each finished in turn. It will be noticed that the smallest diameter is finished last. This is obviously necessary. If shoulder *C* were turned first to its finished size, it would not be stiff enough to support the succeeding cuts *A* and *B*, and give assurance that they would be true with the cone pointed end.

In the fifth operation, the work is supported in a female center (as in Fig. 3, second operation) while formed tools in the front and rear cross slides square up the shoulders already turned, and remove the burrs thrown up by the turning tools. The front cross slide tool forms the small diameter to the left of the collar and squares up the sides of the collar itself. As will be seen from a study of the cams of Fig. 11, the front cross slide tool does not commence to cut until the one in the rear has completed its work. The stock is too slender to permit of too much work being done on it at once. In the sixth operation, the same angular cutting-off tool as shown in Figs. 5 and 6 is used for severing the work from the bar and forming the cone point at the same time. It will be seen that in the operations just described, as in the previous case, the various diameters will be as concentric with the pointed centers of the work as if they had been turned on them.

Description of the Swing Tool.

The swing tool used in operations 3, 4, and 5 is shown in Figs. 9 and 10. To the body *T* of the device is pivoted (about stud *U*) the tool-holder *V*, carrying blade *W*, which is adjusted vertically and clamped by the square-headed screws shown. In a hole drilled into the body of the tool, is contained a plunger *Z* pressed outward by a spring. The opening of this hole is closed by a screw, as shown. A pin *X* driven into the side of tool-holder *V*, projects through a side hole into *T*, and bears on the face of plunger *Z*. By this means the spring keeps *V* swung outward, the movement being limited by the bearing of *Z* on the headless set-screw. Abutment screw

Y, in *V*, is in position to bear against pusher *S*, carried by the cross slide in the same manner as in Fig. 6.

In turning shoulders *A*, *B* and *C* (see Fig. 8), the movements of the front cross slide and turret slide cams, as may be seen in Fig. 11, are so arranged that the swing tool is brought up to the work; the cross slide is next moved in to set the tool *W* to the diameter desired, as determined by the adjustment of screw *Y*; then the swing tool is fed forward the proper distance for the shoulder desired. The front cross slide is next withdrawn, allowing tool *W* to swing outward under the influence of the spring and plunger *Z*. The turret

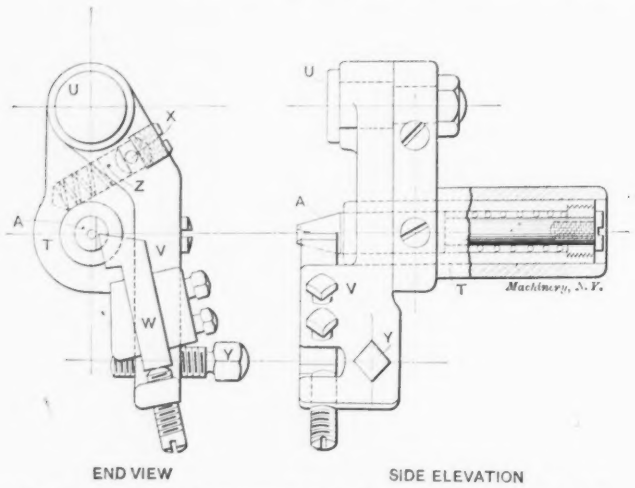


Fig. 10. Details of Construction of the Swing Tool shown in Fig. 9.

slide then retreats, drawing the blade out of the way without allowing it to drag on the work. The swivel adjustment on plate *S* allows either straight or taper turning to be done, as required.

The cams, shown in Fig. 11, for making this part, look somewhat complicated, but the operations may be easily followed. All the various lobes of the three cams being marked for the operations for which they are intended. Legend "I. T." means "index turret." As before, the legend "dwell" indicates a concentric portion of the cam, where the slides are at rest.

In making this piece the spindle revolves at 2,400 revolutions per minute. As shown in Fig. 2, the stock is 0.063 inch in diameter. This gives a surface speed of about 40 feet per minute, the material being tool steel as in the previous case. The net production for these pieces was 1,500

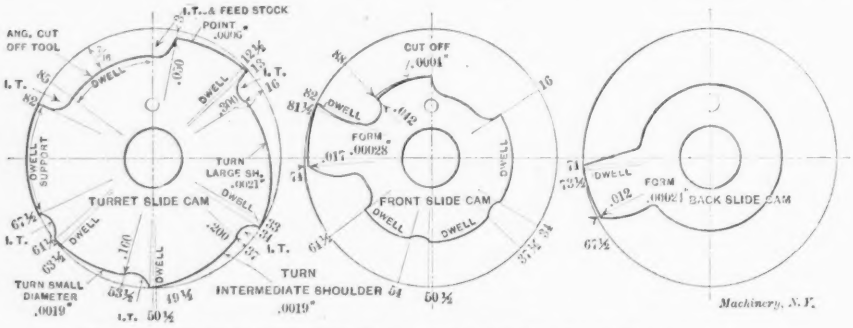


Fig. 11. Turret and Cross Slide Cams used for Making the Staff shown in Fig. 2.

per day. The total revolutions to make one piece is 840, so that each hundredth on the periphery of the cams represents 8.4 revolutions.

We think it will be admitted that this is pretty delicate work to be undertaken by commercial machines not specially designed for work so fine. It is stated that the work is expected to be true to dimension within 0.0005 inch, and that this result was easily obtained by the workmen in the shops of the builders. In the shops of the users of these machines workmen accustomed to watch machinery have been able to do much better than this, showing that the limitations of the machines were not reached in the builders' trials.

For particulars relating to the tools and operations here described, we are indebted to Mr. F. E. Anthony, head tool designer for the automatic screw machine department of the Brown & Sharpe Mfg. Co.

PATENTS AND INVENTORS.*

E. C. SMITH.†

It is written, "a man's foes are they of his own household." Equally true is it that the tribulations of the inventor arise too frequently from causes within himself—usually from insufficiency of knowledge or inadequacy of apprehension. An experience of several years in charge of a corporation patent department brought me in touch with different inventors, and indicated to me that many did not understand what constitutes an invention, or the nature of a patent. To establish an exact definition of invention, that shall serve under all conditions to distinguish invention from mere resource or skill, is practically impossible. The problem has taxed our best jurists, who have been unable to deduce a formula universally applicable under all conditions. In general, however, pure or genetic invention is creation. The phonograph, air brake, "universal" system of winding, are all good examples of genetic invention—the products of the inventor's creative genius.

Subordinate to this is what may be termed constructive invention, or the invention of development and improvement. One man conceived and reduced to practice the mechanism for reproducing human speech—a genetic invention. He and others have made contributory inventions of constructive revision. The origination of the talking machine has stimulated constructive thought in an entirely new field of activity, and thereby the original device has been modified by changes and additions which may or may not have been improvements. Unfortunately, too much of constructive invention is not stimulated by a desire to better an existing invention, but arises from predatory motives and is directed to "getting around it." Because of this fact, such inventive acts were best termed "circumventions," which word best expresses their piratical spirit. As stated by Mr. Johnston, in the March issue of MACHINERY, an inventor may secure proprietary rights in and to his invention by conforming to certain prescribed requirements. I do not agree with Mr. Johnston that the inventor's title to his invention is essentially coextensive with a land title. Land is "real" or tangible property, susceptible of explicit definition as to its boundaries, while an invention is intangible, its boundaries are not so easily defined, and it is more subject to qualifying modifications. The relation of tangible and intangible property is too extensive a subject for discussion here, but it is well to bear in mind that the land-holder and miner secure their property only because the government sees fit to grant the title, just as it sees fit to grant a title to an invention. In short, both are matters of government prerogative, and there must essentially be a wide divergence of opinion as to how the prerogative should be exercised. It does seem inconsistent, however, to propound perpetual title to invention as inherent, and in almost the same breath approve an enforced limitation of tenure.

A patent is a contract between the public, by its representative, the government, and the patentee; and the patent document is evidence of proprietary rights, duly recorded. The applicant alleges that he has invented something new and useful; provided his allegation is true, the public will accord him exclusive rights in and to his invention for a period of years. At the patent office are maintained extensive records of patented inventions, both domestic and foreign, and a patent is issued only after due investigation and comparison of the application with these records, and provided the invention is not found in the prior act or in some application pending before the patent office, and provided that no fraud has been detected in the preparation or proescution of the application. Having secured his patent, the inventor has attained two things, *viz:* a more or less uncertain asset on which he may or may not raise money, and a status or basis for suit

* For additional information on this subject, see the article "On the State of the Patent Office," published in the March issue of MACHINERY.

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before the courts. The law provides no guarantee of the validity of the invention, nor does it, as Mr. Johnston avers, provide any penalty for infringement. It provides means for securing just treatment and damages in case of injury by infringement. Judge Colt stated the position of patent litigation very clearly in Boston several years ago. Speaking for the Appellate Court, in a refusal to entertain discussion of some "legal precedents," he said, in substance, "Cases of this character (patent causes) are not matters of law, but of equity; and equity, in plain English, is simply that which is right and just between parties."

Probably the most disconcerting experience to the inexperienced inventor is the securing of a patent with its crisp parchment, ribbons and seal, and attendant cost, only to find that the invention, though "new and useful," cannot be practiced because dominated by some existing patent. Possibly the dominating patent was disclosed among the first references cited by the examiner, but because it did not show precisely the same form of construction as his own, and he did not find the broad, basic claim, and because he did not understand the law of equivalents, the inventor proceeded with his case supposing he could use his own peculiar construction. An exceptionally clear illustration of the principle of "domination" appeared in a little advertising pamphlet issued by an attorney several years ago. Assume that percussion firearms are unknown. X invents the first percussion device comprising a hammer. He applies for a patent and secures, by broad, basic claims, the sole right to make, use or vend firearms that have hammers. Y sees the disadvantage and danger of employing only a hammer, and invents the trigger, and he likewise secures, by patent, sole rights, title and privilege in the manufacture, use and sale of firearms of which a trigger is a component. But the trigger is dependent on the hammer for its usefulness, and as X has sole right to the manufacture of guns with hammers, Y's invention is useless to him unless he can sell his patent to X, or induce him to use the triggers on a royalty basis, or can secure on a similar basis the right to make guns with hammers, under X's patent, or can manufacture trigger attachments for use on guns manufactured by X. Unaware of this, many would-be inventors, unacquainted with a given field of activity, attempt, without any canvass, to devise some supposed improvement, and proceed to seek a patent.

Again, there are some who waste time with what they wrongly dignify as an invention, by applying a device invented for one purpose to some other purpose. This is done many times in a belief that the various classifications in the patent office are distinct fields of enterprise, and that the importation of an invention from one to another is as patentable as the original creation and development. Generally speaking, a patent protects its invention in all its uses, though there are exceptions when the work of adaptation involves distinct inventive ability, which is recognized. For those who study and analyze, securing information regarding the field in which they propose to work, there is ample opportunity in the realm of constructive invention. The field of purely genetic invention is becoming rapidly more limited, and patent values are differentiated on narrower margins of constructional difference. This is as it should be, because minor constructional variations are frequently productive of large commercial results. As a matter of fact, the inventor has exceptional privileges and opportunities under our patent system. If he elects to prosecute his own patent application, he may do so, bound by no fine technicalities, and, for his guidance, provided gratuitously with one of the most complete, and clearest compilations of rules and directions, clearly illustrated and supplied with skeleton forms for any and all possible actions. One of your correspondents implies that no particular erudition is required to prosecute a patent application. It is true that many inventors successfully prosecute their own cases, and it is likewise true that many professional attorneys are pitifully incompetent. Nevertheless it is also true, that just as some individuals find best expression for their abilities in mechanical conceptions, some in mechanical construction, and some in the commercial exploitation of mechanical products, so others, peculiarly able because of their command of language and resourcefulness of apt expression, can best reduce the inventor's conceptions to record form. If, however, the inventor would exercise the same diligence in delving into the realm of invention that the average business man exercises in his conduct of affairs, he would avoid many pitfalls, and his passage through what is usually pictured as a veritable slough of despond would be more expeditious and less gloomy.

Regarding the patent office, there is much to be said. That the funds earned by it are not available for its own use seems wrong. That there are deficiencies and abuses appears inevitable; they are to be found everywhere. Judged by the commissioner's report, his department seems to be doing all it physically can, as at present constituted. To me the showing is not one of incompetency, but of exceptional merit under adverse conditions. The commissioner states that the work of some of his force is frivolous, and otherwise lacking in essential qualities. What can be expected when men's work is demanded in exchange for boys' pay? It has been my good fortune to meet one or two of the examiners personally, and these were keen, clear-headed and able men. One must remember that they have little access to the concrete embodiment of the inventions on which they pass. Their knowledge of the technical ground they must cover is derived chiefly from the text and illustrations of the patent records and applications in their hands. It is always more difficult to understand a written description than to understand the embodiment of an idea. Does the inventor who desires to negotiate capital, content himself with sending a written description to his prospective financier? No, he wants *him* to see the *machine*. Whether he will see it or not is a matter of volition, and whether or not he will "back" it, likewise. With the examiner, this is not the case. He may not have opportunity to see the machine, yet he must grasp the spirit of the invention and apprehend its advantage with, too frequently, insufficient description to guide him. It is charged that examiners sometimes make immaterial and irrelevant references. Whether this is as flagrant a wrong as might appear on the surface is questionable. If actually done under stress of extreme congestion, it keeps things moving in the patent office, and may throw unexpected light on the subject in hand. Sometimes a reference is declared immaterial because it relates to a distinctly different class of articles from that which includes the subject of the application. But it may be material, nevertheless, under the doctrine of a patent protecting an invention in all its uses. The real danger arises, not from citing irrelevant material, but from failure to perceive that which is vitally relevant and liable to cause trouble to the patentee should he secure a patent and attempt to practice his invention.

In regard to delays, no one can view with complacence the proposition to delay action on the cases of those who desire delay. On the other hand, due deliberation is better than undue haste. Mr. Johnston would have us believe that a multitude of inventors are suffering from lack of funds, due to non-issuance of patents. I will venture a guess that for every one individual in such a plight, there are ninety-nine who hold issued patents and still similarly suffer. Indeed, reasonable delay is not without its advantages. Sometimes, in course of delay, an inventor finds that while he has produced the invention of his application, his analysis is at fault and his original claims inadequate. He may then be able to fortify his case, whereas, had it been immediately acted on, pushed through the office, and a patent issued, the insufficiency might have passed unnoticed until too late, resulting in reissue for correction, or what is worse, a disclosure of the weakness by which some pirate could profit and depreciate if not annul the value of his patent.

Referring again to reference patents, one fact which disposes me leniently toward the examiner is the fact that the inventor himself frequently encounters difficulty in discerning the relation of a cited patent to his own invention. Mr. Johnston suggests one action which, to say the least, seems of dubious utility, *viz:* to penalize the deferment of a request for division until after several actions. What difference does it make to the applicant when he is asked to divide his application? If he must divide it, he must pay two fees; so why throw the second fee on the examiner for any cause?

If there are any penalties to be meted out, they are due the man who wastes time in needlessly dissecting the punctuation and phraseology of an application. It has been officially decided that such criticism is ill-judged and misdirected.

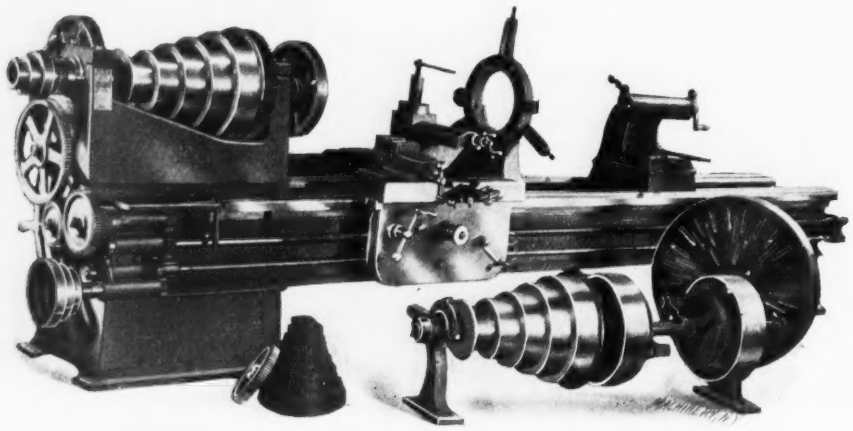
The essentials of an adequate application are simply clear, intelligible composition in the English language, according to prescribed forms. The suggestion that the commissioner be made general manager, with unlimited credit, seems untimely, when Congress is holding onto the funds earned by the patent office. It seems essential that something be done, however, and the most feasible move would appear to be a concerted action to impress Congress with the needs of the situation. The realm of invention touches every phase of our industrial welfare and development. It is not local in any aspect, but reaches and affects the uttermost parts of our land, and indeed, of the world. It should be an easy matter to convince Congress that something needs to be done and must be done.

It must be realized, of course, that we have passed through extraordinary times. The demand for skilled labor has exceeded the supply. Several engineers have graduated from the Panama Canal work. Our military establishment is depleted because men can find better inducements in the industrial world than in army life. Works managers at large have bewailed the scarcity of help. Is it any wonder that examiners resign from the patent office at the rate of one a week? As for commercial firms and their business methods, there are some from whom we purchased our supplies who didn't know the nature of a promise, and beside whose methods those of the patent office could shine with the effulgence of perfection. It is easy to make invidious comparisons, but the instability of the premises on which such comparisons are based has made be a cynic.

* * *

AN OREGON LATHE.

The accompanying illustration shows an engine lathe built by the Eugene Iron Works (G. N. Frazer, proprietor), Eugene, Ore. This shop, we believe, is the only one on the Pacific slope that builds lathes for sale. The lathe illustrated is 30 inches swing and takes 10 feet between centers. The spindle is hollow, having a 2½-inch hole. The tail-stock is of the well-known cut-away pattern which permits the compound rest to be swung around parallel with the ways without interfering with the tail-stock. This lathe is not the first lathe



A 30-inch Lathe built by the Eugene Iron Works, of Eugene, Ore.

built by the Eugene Iron Works. We are informed that several others have been built, one of them being 44 inches swing and 12 feet between centers. This example was built twenty-eight years ago, and is still doing good work. It was made in sections that could be planed on a 22 x 6-foot planer, and it has the much-talked-of double plate apron, now pushed as a comparatively new feature by many prominent lathe builders. We are indebted to Mr. Ed. B. Eby, of Eugene, Oregon, for the above information.

* * *

The English turbine-driven torpedo boat destroyer *Tartar*, during her official trials, developed a speed of 35.672 knots as a mean of six runs.

A POWER-PRODUCING PLANER.

GREBO.

I often think it is a great pity that some of the wonderful achievements of machinery, as related by certain accomplished traveling men, do not agree with the fundamental laws of mechanics. These stories sound so well that it seems they ought to be true, and if they were true, what a different world this would be! It really would be a pleasure to run a machine shop. For example, having a certain tale in mind, we would grow richer day by day by simply running a shop and selling power to our neighbors. Now you think this sounds "fishy," and I will explain how it could be done (?) much simpler than has ever been proposed before. You, of course, have heard of steam engine and boiler installations that were equipped with various improved appliances, some of which saved 10 per cent of the fuel, others 15 per cent, and still others as much as 25 per cent. By using enough of these wonderful affairs the point was reached where instead of consuming coal the plant was able to turn out half a ton of coal a day for some other fellow to burn. Now this was a very clumsy affair, not really worth the while of an up-to-date factory economist. You always have a feeling that a salesman will come along some day with a smoke-consumer or an ash-burning compound that will make all your previous economies look like thirty cents. Real improvement is in the direction of simplicity, and that is what I am going to tell you about.

I knew a salesman who sold planers—rather big planers, heavy and clumsy-looking affairs, but wonderful machines for all that. Of course his "spiel" was that these planers were better in all working points than any other planer built, or that ever would be built. But customers had heard these stories before and discounted his talk 66 2/3 & 25 & 10 & 10 & 5 per cent in approved commercial style. They would look at his pictures and his specifications and ask him about the power required to drive the big machine. Right here is where our salesman made a claim that firmly fixed his reputation. He admitted the planer would need something like 20 horsepower to start it, but when once it was started, why he had known of a great many cases where the planer ran so easily that instead of the engine running the planer, the planer was actually helping out the engine!

Now this proposition is more attractive than may be realized at first. Most manufacturers do not care for a few horse-power more or less. Power is a small part of their expenses, anyhow, but when you had bought one of these planers you had a very useful machine. It not only required no power after it was once started, but actually contributed to running the other tools in the shop. With a sufficient number of these planers running you could run your entire shop and have a surplus to light it; or, if enough planers were operated, you might run the street car lines of the town!

It is painful to record that the rosy prospects an active imagination might conjure from the unqualified statements made by our salesman did not excite the imagination of his prospective customers. They listened coldly to his eager words and his sales fell considerably below those of his fellow salesmen. Finally he was called home and asked to explain the "becauseness of the why," and his customary "spiel" was poured into the astonished ears of the general manager, who could scarcely believe what he heard. Finally, when the manager got his breath, he let out a few wrathful comments punctuated with exclamation points, on the asininity of the power claim and the ridiculous position that our smart salesman had put himself into. The salesman learned more about the conservation of energy and the limitations of machines as power producers in those few hot minutes than most of us learn in several years of schooling.

If there is any particular point to be impressed by this foolish tale it is that manufacturers should employ salesmen only who know what they are talking about.

ADVANCED DESIGNS OF GERMAN DRILLING MACHINES.

OSKAR KYLIN.*

The accompanying half-tones show a few types of the extensive line of drills manufactured by the Dresdner Bohrmaschinenfabrik, A.-G., Dresden, Germany. This firm manufactured originally, in accordance with the common practice of nearly all German machine tool builders, all types and sizes of machine tools, without specializing in any; but, learning of the success of the specialization of the American machine tool makers, and clearly seeing the advantage of this, and with how much less amount of labor an equally large amount of work could be produced by systematizing the output, as compared with the old method, this firm discontinued the making of all kinds of machines except drilling machines, and devoted itself exclusively to this one line.

Figs. 1, 2 and 3 show some of the small sizes of drills, of the single spindle as well as the multiple spindle type, intended for ordinary light or medium grade work, and equipped only with hand feed. There is nothing startling in the design of these machines, as they follow the general line of design which for years has been brought out by many different machine tool builders, and proved to fill the requirements. It will be noticed, however, that in many features these machines are different in their appearance from common American types, and that the multiple spindle drills, in particular, are of a heavy and substantial design. The drills shown in Figs. 2 and 3 are also built with a greater number of spindles, if required.

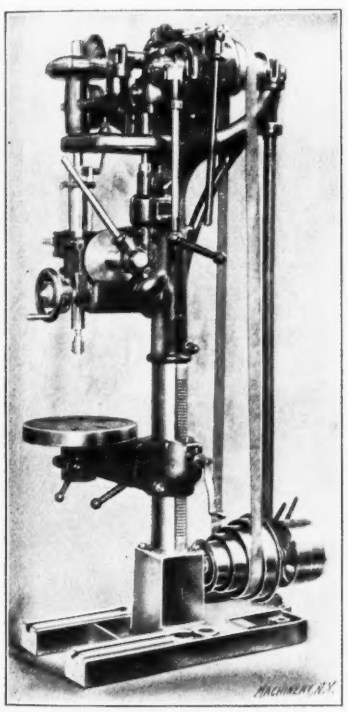


Fig. 1. Regular Type Upright Drill built by the Dresdner Bohrmaschinenfabrik.

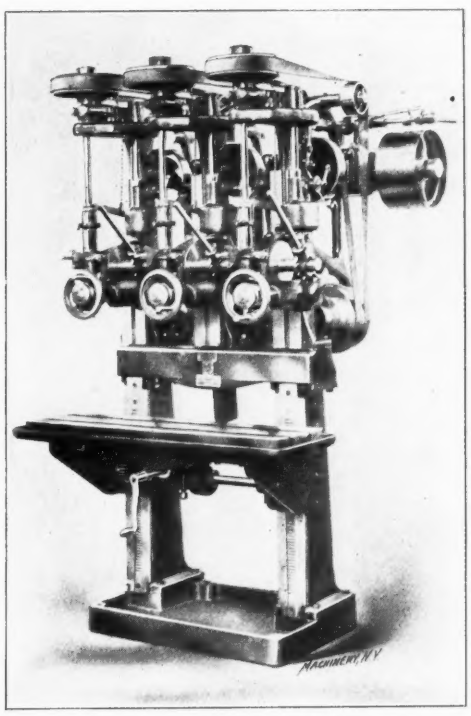


Fig. 2. Three-spindle Drill, of Heavy and Substantial Design.

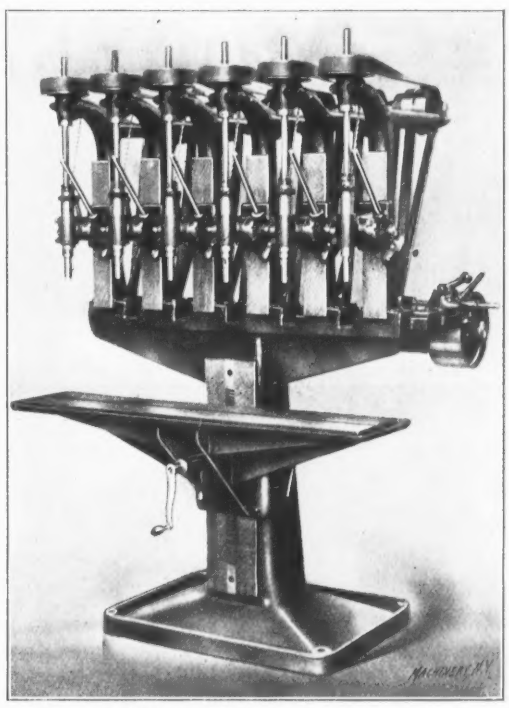


Fig. 3. Multiple Spindle Drill for Light and Medium Grade Manufacturing.

In Figs. 5, 6, 7 and 8 are shown the large types of drills manufactured by this company, equipped with power feed and designed for heavy duty. The machine in Fig. 8 is equipped with a pump and arrangement for water cooling of the drill, while at work. It will be noticed that all gearing is very carefully covered with guards, forming integral parts of the machine. The radial drill shown in Fig. 7 is of particular interest. It will be seen that the design is unusually rigid and that the column as well as the arm is very heavy. The column is mounted on a base-plate provided with T-slots, which serves as a support for large work, when the small table is swung aside as shown in the half-tone. This machine is provided with single pulley, all-gear drive, the speed changing mechanism being operated by the handle shown at the back of the column. In this machine also it is noticeable how carefully all gearing has been covered. The design, in general, is clearly shown in the engraving, and may be studied directly from this without further comments.

In Fig. 4 is shown an interesting type of turret drill, which is radically different from anything else hitherto presented in drill press design. This machine is of an exceptionally heavy and rigid design throughout, in accordance with the work for which it is intended. It is provided with a single pulley, all-gear drive, the speed changing device being operated the same as in the radial drill press, Fig. 7. Power is transmitted to the top of the drill by means of bevel gearing and a shaft located centrally in the column. The drill spindles are driven through shafts connected at one end through bevel gears to the central shaft, and at the other end by bevel gearing to the drill spindles, these shafts being arranged radially, one for each spindle. There are five spindles in the turret arranged around the central column, but power can be transmitted to only one at a time; that is, to the one directly above the table of the machine. This prevents undue consumption of power, and unnecessary wear of spindles, gearing and bearings. The engaging and disengaging of the power to and from the spindles is effected by a cam and clutches, brought into operation as the turret is being slowly revolved by hand around the column. The clutches are located on the radial shaft near the outer bevel gear. The cam by which the clutches are engaged and disengaged is located below the gear mechanism at the top of the drill, and immediately on the top of the column, as can be plainly seen in the half-tone. When the spindle is moved into position the respective clutch is being engaged, and when again moved out of position, the clutch is thrown out of mesh. In order to make it easy to revolve the turret, this rests on ball bearings. Attention should be called to the rigidity of the design, and to the construction of the drill table, the features of which can be seen plainly from the half-tone. This drill is equipped with pump and arrangement for water cooling. As the five different spindles are intended for different kinds of work, drilling, reaming, tapping, etc., they can be run at different speeds suitable for each kind of work. These different speeds are obtained by different sizes of bevel gears for driving the different spindles.

A feature that will be noticed in all the designs brought out by the Dresdner Bohrmaschinenfabrik is that the unit system of design is employed to the largest possible extent. One unit, as, for instance, the heads and the gear boxes, will be found to be the same on many of the different types of the machines represented in the accompanying half-tones. Many times a new type of machine is brought out by simply making new

* Foreign Traveling Representative of MACHINERY.

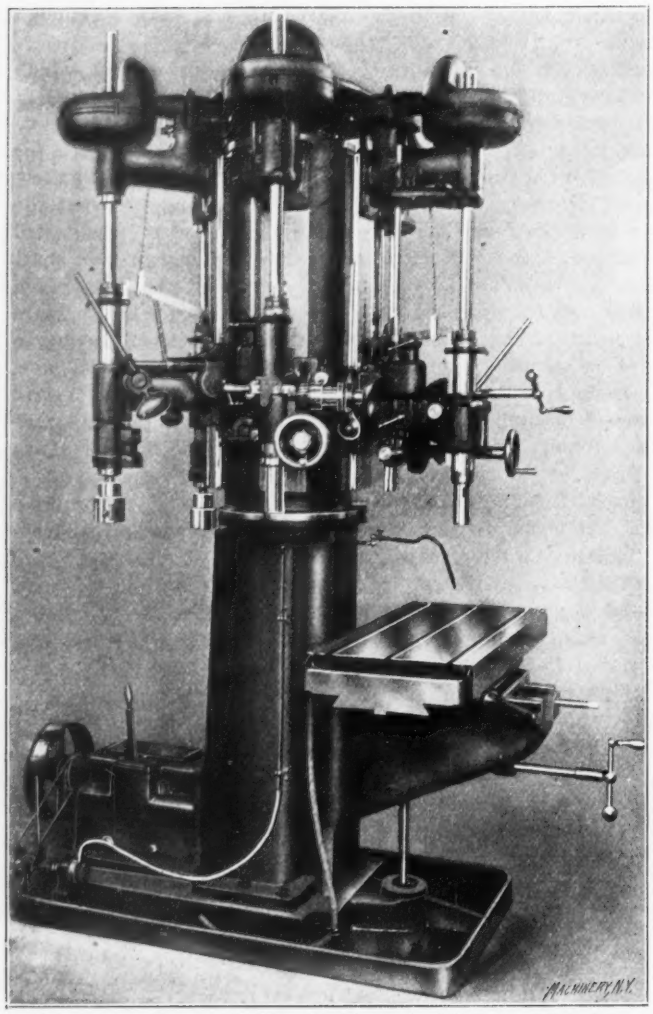


Fig. 4. Turret Type of Drilling Machine embodying Turret Principle in Drill Press Design.

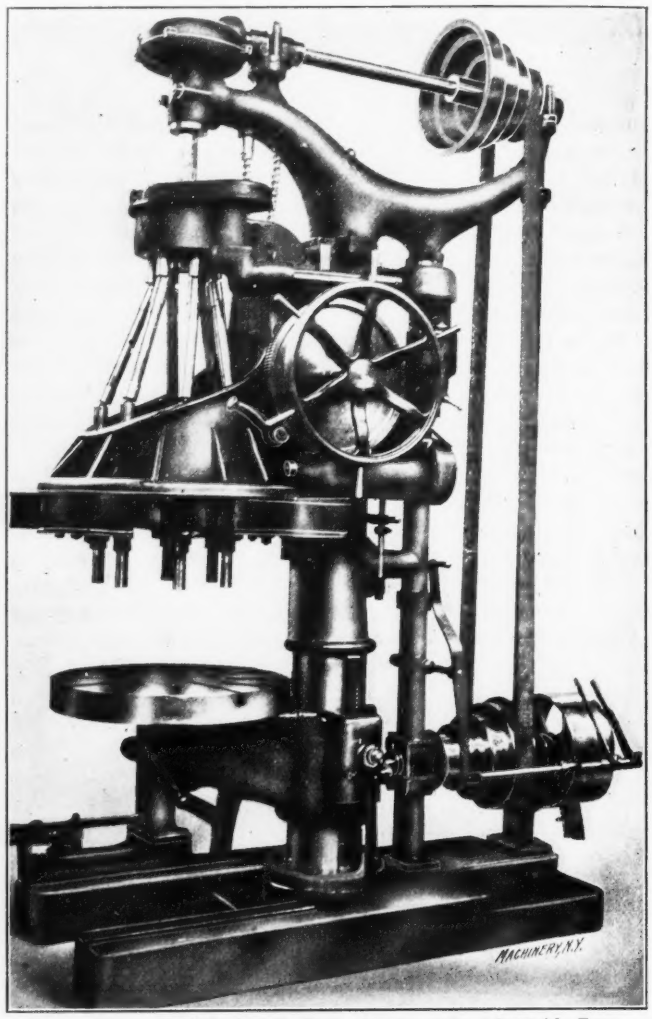


Fig. 5. Heavy Multiple Spindle Drill of Universally Adjustable Type.

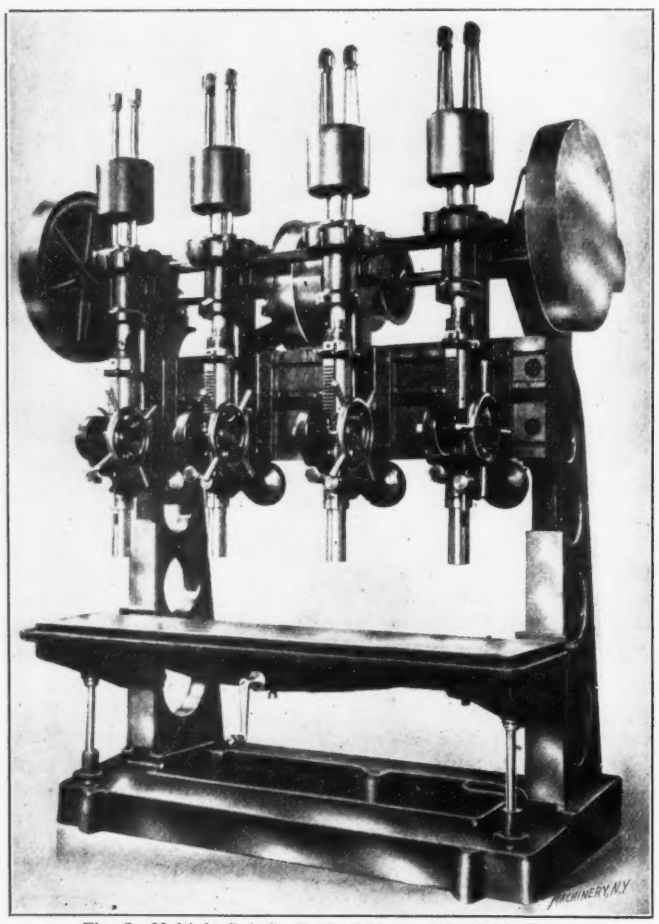


Fig. 6. Multiple Spindle Drill of Linear Adjustable Type.

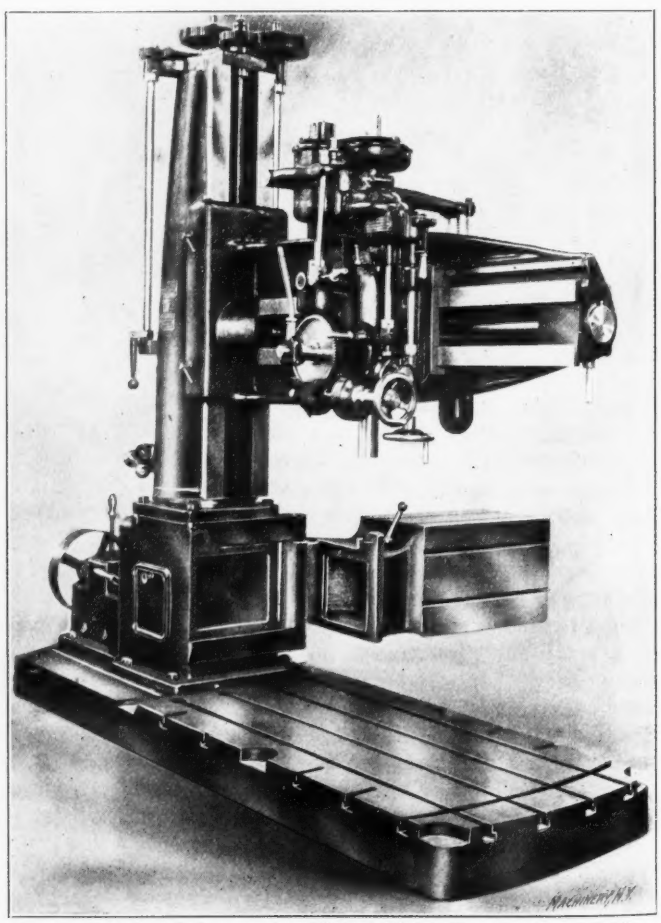


Fig. 7. Dresdner Bohrmaschinenfabrik Radial Drill, with Hinged Table.

main castings and then employing the units used for other types. Thus, a manufacturer of a special line of machine tools can afford to carry a large number of types, and still have the advantage of specialization. Various details and whole units can be made in very large numbers and kept in stock, and the building of a new machine may simply mean bringing out

and machining the main castings, and assembling the various units for making up a complete tool.

All the machines provided with power feed for the drill are provided with feed changing mechanism. This feed changing arrangement is shown best in Fig. 4, on the side of that spindle which is in position over the table, and is operated by the small handle shown. Three different feeds for each spindle speed are obtainable. A small matter, which, however, is well worth noting, is that all the nuts on the machine, which occasionally need to be loosened for the sake of setting the table or adjusting some other part, are provided with handles. This, many a time, means a great saving, as compared with having the ordinary hexagon nuts, which have to be unscrewed and tightened by a wrench, because it is well known that entirely too much time is lost in shops by hunting for wrenches.

In order to reduce the power consumption and also the wear of the machines, all principal bearings are made with

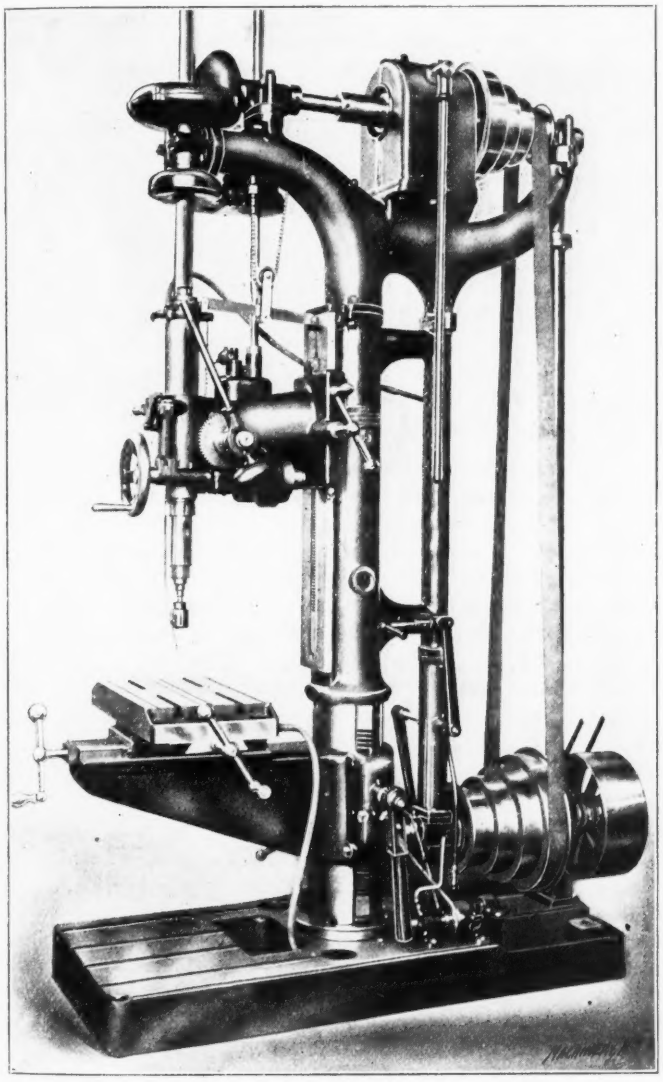


Fig. 8. Heavy Design of Upright Drill Press.

ringed oiling devices or ball bearings. It is very noticeable in many German shops that more attention is paid to the power consumption of the machine tools than is done in the average American shop. Thus, in the Dresdner Bohrmaschinenfabrik's shops, all ordinary sized and large drills are tested in regard to power consumption before being placed in the stock room, or delivered to customers, the power consumption being noted when the drill is running idle as well as when performing work.

A special and rather unique feature employed in the manufacturing of these drills is that after having been once assembled in one department, they are taken apart and re-assembled in another department by entirely different men. This is done, the company claims, in order to find all possible defects in the machines, and secure nice running conditions everywhere in the finished drill press.

JIGS AND FIXTURES—3.

EINAR MORIN.*

LOCATING POINTS.

The locating points in a jig usually consist of finished pads, bosses, seats, or lugs, cast solid with the jig, as illustrated in Fig. 18. In this engraving the surfaces marked *f* are the locating points, which bring the piece to be machined in right relation to the bushings guiding the drills, or to the gages to which other cutting tools may be set. This way of locating the work is satisfactory when the work done is finished in a uniform way, and where there is very little variation in the parts inserted in the jig.

Another commonly used means for locating the work in jigs is by means of dowel pins, as shown at *A* and *B* in Fig. 19.

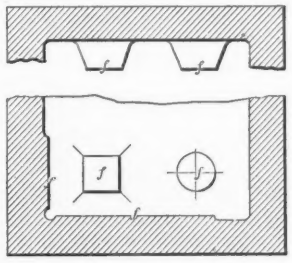
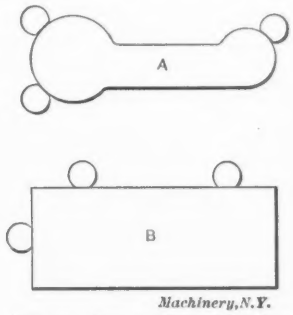


Fig. 18. Locating Pads in Jigs.



Machinery, N.Y.

Fig. 19. Pins used for Locating Work.

The sides of the dowel pins which rest up against the work are usually flattened, as indicated, so as to give more bearing than a mere line contact with the pins could give, and, at the same time prevent too rapid wear on the locating pins, as would be the case if the work should bear against the pins along a line only.

Sometimes pins or studs are inserted in jigs to act as locating points, instead of having lugs cast directly on the jig, as shown in Fig. 18. A case where a pin is used for this purpose is shown in Fig. 20, where *B* is the body of the jig, *A* the pin inserted to act as a locating and resting point, and *C* the work located against this point. Locating pins of this character should always be provided with a shoulder or collar,

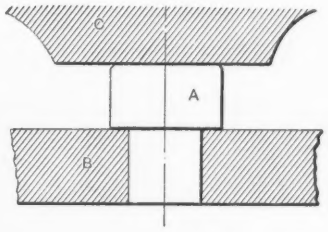
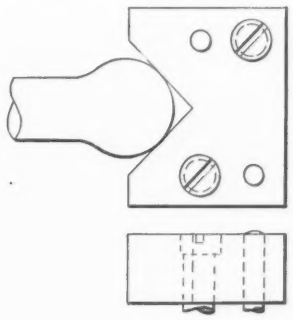


Fig. 20. Inserted Pin used for Locating and Supporting Work.



Machinery, N.Y.

Fig. 21. V-block for Locating Round Work or Cylindrical Surfaces.

so that there is ample security that they will resist the pressure of the work they support, without possibility of moving in the hole in which they are inserted.

A common method of locating cylindrical pieces or surfaces is that of placing the cylindrical surface in a V-block, as shown in Fig. 21. This V-block as a rule is stationary, and is held in place by screws and dowel pins, as indicated in the engraving, but sometimes these V-blocks may also be made adjustable, in order to take up the variations of the pieces placed in them, and also in order to act as clamps. A V-block of this character is shown in Fig. 22. In this, *A* is the adjustable V-block, having an oblong hole *B* to allow for the adjustment. The block is held down in place by a collar-head screw *C*, which passes through the elongated hole. The under side of the block is provided with a tongue *D*, which enters into a slot in the jig body itself, the V-block being thereby prevented from turning sideways. The screw *E* passes through the wall of the jig, or through some lug, and prevents the V-block from sliding back, when the work is inserted into the jig. It

* Address: 833 W. Sixth St., Plainfield, N. J.

is also used for adjusting the V-block, and, in some cases, for clamping the work. The V-blocks are usually made of machine steel, but when larger sizes are needed, they may be made out of cast iron. Little is gained, however, in making these blocks out of cast iron, as most of the surfaces have to be machined anyway, and the difference in the cost of material on such a comparatively small piece is very slight.

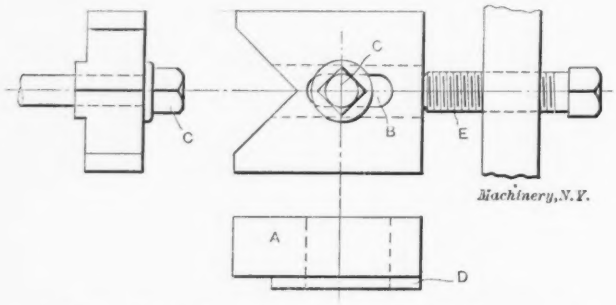


Fig. 22. Adjustable V-block used for Locating Purposes.

When it is essential that a cylindrical part of the work is located central either with the outside of a cylindrical surface, or with the center of a hole passing through the work, good locating means are provided by the designs shown in Figs. 23 and 24. In Fig. 23, the stud *A* is countersunk conically to receive the work. The stud *A* is made of machine or tool steel, and may, in many cases, serve as a bushing for guiding the tool. In Fig. 24, the stud is turned conically in order to enter into a hole in the work. These two locating appliances are always made stationary, and are only used for locating the work, never for binding or clamping.

Screw Bushings and Sliding Bushings Used as Locating Means.

Screw bushings of the type which has already been shown in Fig. 14 (May issue), may be used for locating and clamping purposes by making them long enough to project through the

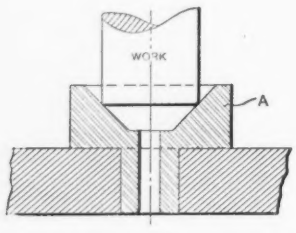


Fig. 23. Recessed Stud used for Locating Round Work.

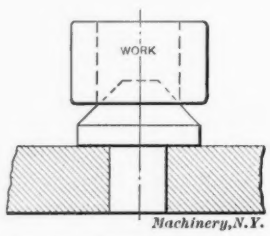


Fig. 24. Conical Stud used for Locating Work in Relation to the Center of a Hole.

walls of the jig, and by turning a conical point on them, as shown in Fig. 25, or by countersinking them, as shown in Fig. 26.

Another type of bushing which serves the same purpose as a screw bushing is illustrated in Fig. 27. This bushing, together with the forked lever *D*, and clamping bolt and wing nut shown, will serve not only to locate but also to clamp the work in place. This sliding bushing gives very good results and is preferable to the screw bushing in cases where accurate work is required, but, as a rule, where extreme accuracy would be required, this kind of bushing is not used.

In Fig. 27 the sliding bushing *A* has a close sliding fit in the lining bushing *B*. In the head of the bushing *A* there are two screws with hardened heads, which fit into elongated slots in the forked lever or yoke *D*, which, in turn, swivels around pin *E*. The eye-bolt *F* fits into a slot *G* in the yoke, and the wing nut tightens down the bushing against the work as clearly indicated in the engraving. A comparatively long bearing for the bushing is required in order to produce good results. On work that varies considerably in size this arrangement works somewhat quicker than does a screw bushing, but it is clearly in evidence that it is a rather expensive appliance, and that the construction of the jig does not always permit of its application.

In some instances it is necessary to have the screw bushing movable sideways, for instance, when the piece of work to be made is located by some finished surfaces, and a cylindrical part requires to have a hole drilled exactly in the center of a lug or projection, the relation of this hole to the finished surfaces used for locating, being immaterial. The piece of work, being a casting, would naturally be liable to variations between the finished surfaces and the center of the lug, particularly if there be other surfaces and lugs with which the already finished surfaces have to tie up, and in such a case, the fixed bushing for drilling a hole that ought to come in the center of the lug, might not always suit the casting. In such a case, so-called floating bushings, as shown in Fig. 28, are used. The screw bushing *A* is conically recessed, and locates from the projection on the casting. It is fitted into another cylindrical piece *B*, provided with a flange on one side. The piece *B*, again, sets into the hole *C* in the jig body *D*, this hole being large enough to permit the necessary adjustment of the jig bushing.

When the bushing has been located exactly concentric with the lug *E* on the work, the nut *F*, having a washer *G* under it, is tightened. It will be seen that the flanges on piece *B* and the washer *G* necessarily must be large enough to cover the hole *C* even if *B* is brought over against the side of the hole. The occasion for using this floating bushing, however,

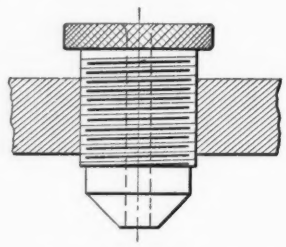


Fig. 25. Screw Bushing used for Locating Work Central with a Hole.

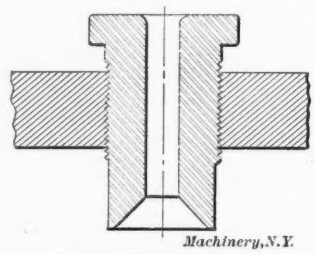


Fig. 26. Screw Bushing used for Locating Round Work by means of a Conical Recess.

does not often occur, because it is seldom that a drilled hole in a piece of work can be put in without having any direct relation to other holes or surfaces.

Adjustable Locating Points.

The most common form of adjustable locating points is the set-screw provided with a check nut, as shown in Fig. 29. The screw *A* is a standard square head set-screw, or, in some cases, a headless screw—with a slot for a screw driver; this screw passes through a lug on the jig, or the jig wall itself, and is held stationary by a check nut *C* tightened up against the wall of the jig. Either end of this screw may be used as a locating point, and the check nut may be placed on either

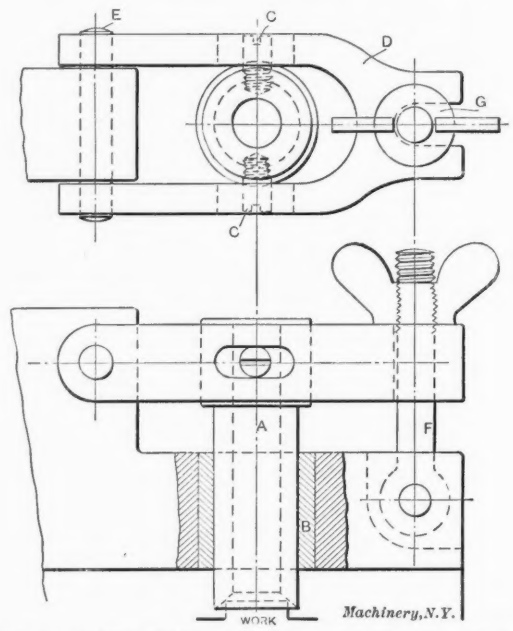


Fig. 27. Sliding Bushing for Locating and Clamping Work.

side. By using a square head screw, adjustment is very easily accomplished, but unless the operator is familiar with the intentions of the designer of the jig, locating points of this kind are often mistaken for binding or clamping devices, and the set-screws are tightened up and loosened to hold and release the work, when the intention is that these screws should be fixed when once adjusted. It is not even possible

to depend upon the check nut stopping the operator from using the screw as a binding screw. A headless screw, therefore, is preferable, as it is less apt to be tampered with.

The sliding point, as illustrated in Figs. 30 and 31, is another adjustable locating point which is used to a great

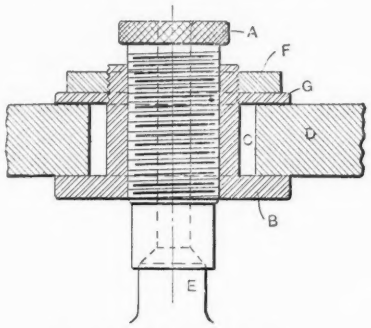


Fig. 28. Floating Bushing.

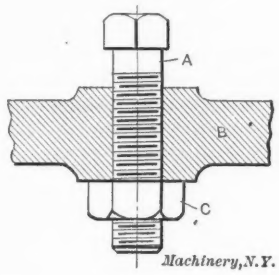


Fig. 29. Simplest Form of Adjustable Locating Point.

extent in jig work. A flat piece of work or a plate which is not perfectly level will always rock if put down on four stationary locating points, but the difficulty thus encountered is very easily overcome by making one of the locating points adjustable, and, as a rule, the sliding point is used for this purpose.

The design shown in Fig. 30, where *A* represents the work to be located, *B* the sliding point, itself, and *C* the set-screw, binding it in place when adjusted. The sliding point *B* fits a hole in the jig wall and is provided with a milled flat slightly tapered, as shown, to prevent its sliding back under

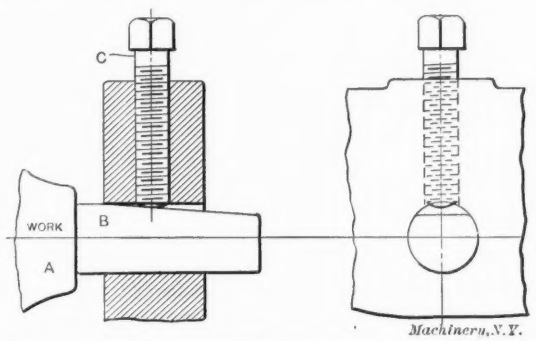


Fig. 30. Adjustable Locating Point consisting of a Flatted Stud held in Place by Set-screws.

the pressure of the work or the tool operating upon the work. This design of sliding point is frequently used, but it is not as efficient as the one illustrated in Fig. 31. In this design the sliding point *A* consists of a split cylindrical piece, with a hole drilled through it, as illustrated in the engraving, and a wedge or shoe *B* tapered on the end to fit the sides of the groove or split in the sliding point itself. This wedge *B* is forced in by a set-screw *C*, for the purpose of binding the sliding point in place. Evidently, when the screw and wedge are forced in, the sliding point is expanded, and the friction

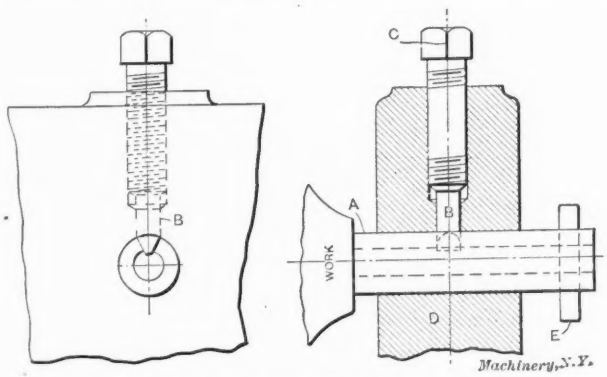
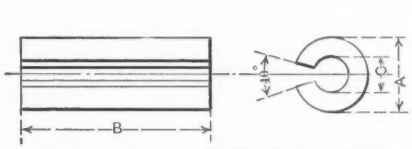


Fig. 31. Sliding Point used for Locating Work.

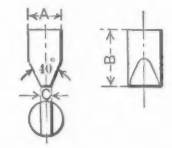
against the jig wall *D* is so great that it can withstand a very heavy pressure without moving. Pin *E* prevents the sliding point from slipping through the hole and into the jig, when loosened, and also makes it more convenient to get hold of. In Figs. 32 and 33 are given the dimensions most commonly used for sliding points and binding shoes and wedges.

If the work to be finished in the jig has some holes already finished, it is sometimes most satisfactory to locate the work by these holes, which may be done by means of studs or plugs similar to the one shown in Fig. 20, which then enter the holes; preferably, these studs should then be ground and hardened to the standard size of the hole. If the finished hole should be of a character that varies somewhat in size, expansion studs with bushings may be used. These studs may be of a great many different designs and styles, but, as a rule, they always work on the same principle as the one shown in Fig. 34. In this, *A* is the bushing, fitting the finished hole in the work. This bushing is split in several different ways, either by having one slot cut entirely through it, and two more slots cut to within a short distance of the outside periphery, or by having several slots cut from the top and from the bottom, alternating, but not cut entirely through the full length of the bushing. The matter of splitting, however, in every case, accomplishes the same object, that of making the



A	3/8	1/2	5/8	3/4
B	2¼ TO 3	2¼ TO 3	2¼ TO 3	2¼ TO 3
C	3/16	1/4	5/16	3/8

Fig. 32. Dimensions of Sliding Points.



SCREWS	5/16	3/8
A	1/4	5/32
B	1/2	5/8
C	1/16	3/32

Fig. 33. Dimensions of Shoes or Binders for Sliding Points.

bushing capable of expansion, so that when the stud *B*, which is turned to fit the tapered hole in the bushing, is screwed down, the bushing is expanded.

Locating by Keyways in the Work.

Sometimes the work to be finished in the jig is provided with a keyway or a slot, or with some other kind of a seat, by means of which it is located on its component part on the machine for which it is ultimately intended, and it is always essential that the work be located in the same way in the jig as it is to be located on the machine on which it is to go; thus, if the work has a keyway, suitable for locating, a corresponding keyway ought to be put into the jig, and the work located by means of a key, as shown in Figs. 35 and 36.

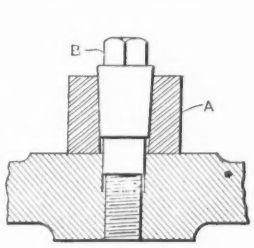
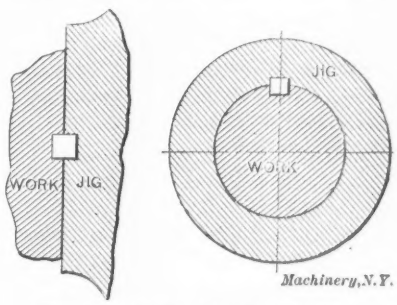


Fig. 34. Expansion Bushing used for Locating and Clamping Work.



Figs. 35 and 36. Locating Work by Keyways.

Instead of a loose key, a tongue may be planed or milled solid with the jig, but, as a rule, it is more satisfactory to have the loose key, as, if it should happen to wear, it is possible to replace it; and if the width of the keyway should vary in different lots of the parts made, it is possible, with little expense, to make a new key to fit the variation, whereas, if the key is made solid with the jig, and found to be either too large or too small, the trouble of fixing this would be considerably greater.

There are, of course, a variety of different methods of locating the work in the jig, depending upon the nature and the shape of the work, but those mentioned above are the most common, the cheapest, and those that, as a rule, give sufficiently good results for ordinary work. The principles involved in the design of the means of locating the work described above, would all be the same in any kind of locating devices, so that it would simply be a difference in application of the principles, rather than a difference in the principles themselves.

SHOP ORDER TRACING SYSTEM.

CHARLES M. POND.*

In suggesting any new system, one must first of all fully realize that the same conditions do not exist in two shops or factories. Hence, the system suggested must be broad and flexible enough to permit of being adapted to the various conditions already in existence. Moreover, the conditions permitting the use and adoption of the system should be carefully analyzed in order that the individual or corporation which is inclined to try the system, may first investigate and see if it can be maintained successfully.

CUSTOMER:

ADDRESS:

CUSTOMER'S ORDER NUMBER	SHIPPING ORDER NUMBER	MATERIAL	SHIPPED

Machinery, N.Y.

Fig. 1. Card on which is recorded Customer's Name and Address, Order Numbers, and Date of Shipment.

The system which the writer is about to present is of chief interest to the manufacturer of tools, instruments, fixtures, and the like. To all those engaged in this work, the daily mail brings its full quota of "tracers," "ticklers," and inquiries. These, in many cases, constitute fully 10 to 15 per cent of all mail received; and if the correspondence is large, their number will be proportionately great, and will require a separate department to give them proper attention and to answer them intelligently and correctly. The customer receives an answer and promise of shipment, and bases his calculations accordingly. If the promise is not kept, it may mean serious loss to him, and consequent ill feeling, and the curtailment of orders placed with the offending concern. Many times it results in cancellation, and consequent loss, if the goods are in any way special. It is therefore evident that care should be taken in replying to these inquiries. Moreover, a manufacturer who has a reputation for keeping his promises of delivery need have little fear of losing his customers, provided his product is satisfactory. That these "inquiries" or "order tracers" before mentioned are very common is evidenced by the fact that almost every concern which buys at all, has a printed form which is sent to the seller, asking that most important, and often vexing, question: "When can you ship?"

Now, having the conditions existing as outlined, it remains for the manufacturer to give an immediate and satisfactory answer; and this is where the value of a comprehensive and practical system will make itself felt. It is the writer's object to lay out such a system as can be easily adapted, and will not require much outlay to install.

First let us see where and under what conditions this system may be used. It will be of chief value, as has been said before, to the manufacturer of small articles such as drills, tools, fixtures, and the like, where a great variety of stock is kept constantly on hand, and for which there is a steady demand. It will also be of most value to the factory having its machines grouped in departments according to kinds of operation. It can readily be seen that, in the case where the complete tool is made entirely in one department under the direct supervision of one foreman, the time of completion of any article or order is readily determined. But this manner of dividing machinery is gradually being replaced by the modern and vastly more economical method of having machines of one type grouped together in one department. This department is under the supervision of an expert in that line, and but one operation is performed under his jurisdiction. For example, we can assume that a concern makes twist drills of a great variety. It would be entirely possible to have one department make the common drill complete; another department, the high speed drill; still another, the wire drill, etc. But the proper way is to have it so arranged that one department cuts off the stock, another does the milling, another the turning, another the grinding, and so on. It is because of the almost universal adoption of this latter arrangement of machinery that it is often difficult to estimate with accuracy the exact date of completion of any order, especially if it must pass through many departments, and take its turn. Hence a follow-up system is necessary, and every manufacturer will find it to his advantage to have one on which he may rely.

Of course, the financial question comes up: "Can I afford to install and maintain a system?" The writer has considered this phase of the question, and has outlined a method that may be readily handled by two men in a shop employing about four hundred hands. With but two hundred men, only one man will be required, and the same proportion holds where the number of men is larger than four hundred.

The first item which comes up for attention is the customer's order. This, as a rule, has a number by which it is known in all future correspondence between the manufacturer and customer. This number is given to it by the customer, and we shall designate it hereafter by the term "customer's order number." Sometimes the date of the order is its only identification as far as the customer is concerned, but this is generally in the case of small concerns.

This customer's order now becomes a definite factor to the manufacturer, and he must keep a record of it in various ways. For this purpose he gives it another number by which he identifies it for his own records. This number may conveniently be called the "shipping order number." In some concerns the customer's order is taken directly to the store-room and there filled, if possible. Other manufacturers make it a practice to transcribe the order to a regular shipping order form, which has the advantage of uniformity in size, and can be more easily understood by store-room and shipping clerks. This form will have the same shipping order number as is given to the customer's order. If the order (which we will hereafter call the "shipping order") can be filled from stock on hand, the material is immediately boxed and sent to the customer, and the shipping order is filed away after all necessary records are made. But suppose for some particular reason the stock necessary to fill the order is not in the store-room, but is in the process of manufacture somewhere in the shop. It then becomes necessary to place the shipping order in a temporary file, and wait until the material in the works is completed, before making shipments. Again, let us suppose that the customer requires something out of the ordinary, that has to be made up especially for him. Then a special working order must be issued to the shop, and the shipping order filed away temporarily until these special goods are completed. Hence it is evident that there will be in the factory two general classes of orders, namely, the orders for stock goods, and the orders for special goods.

SHORTAGE OF:

ON WORKING ORDER NUMBER:

SHIPPING ORDER NUMBER	NUMBER OF PIECES	SHIPPING ORDER NUMBER	NUMBER OF PIECES	SHIPPING ORDER NUMBER	NUMBER OF PIECES

Machinery, N.Y.

Fig. 2. Card on which Pieces not in Stock, but which are required to fill Orders, are recorded.

* Address: 49 Tremont St., Hartford, Conn.

These working orders should all be numbered for reference, and when a special working order is made out for any shipping order, the working order number should be noted on the shipping order, and *vice versa*.

We now have the following papers to deal with:

1. Customer's orders.
2. Shipping orders (which may be the same as No. 1).
3. Special working orders.
4. Stock working orders.

Next let us see what printed forms and card indexes are necessary for the follow-up system.

First we must have a card index consisting of cards, as shown in Fig. 1. After the customer's order has been given a shipping order number, or transcribed to a shipping order form, a record should be entered on this card. At the top of the card is the customer's name and address, and the cards are filed alphabetically, according to the name of the customer. In the first column is entered the customer's order number, in the second column, the shipping order number, and in the third column may be entered, if desired, a short description of the goods. When complete shipment is made, the date of such shipment should be stamped in the last column.

DAILY REPORT.

ON SPECIAL, STOCK, AND MISCELLANEOUS ORDERS GONE FORWARD TO DAY FROM THIS DEPT.

KEY FOR DEPARTMENT NOS.		SPECIAL WORKING ORDER	SENT TO DEP'T. NO.	STOCK WORKING ORDER	SENT TO DEP'T. NO.	MISCELLANEOUS ORDERS	SENT TO DEP'T. NO.
CUTTING OFF DEP'T.	1						
PLANING DEP'T.	2						
TURNING DEP'T.	3						
SCREW MACH. DEP'T.	4						
MILLING DEP'T.	5						
THREADING DEP'T.	6						
BORING & DRILLING DEP'T.	7						
HARDENING DEP'T.	8						
GRINDING DEP'T.	9						
ASSEMBLING DEP'T.	10						
INSPECTION DEP'T.	11						
STORE ROOM	12						

FOREMAN.

Machinery, N.Y.

Fig. 3. Foreman's Daily Report Card.

The next card index required is a "shortage list." This is complied from a shortage sheet of any convenient form, made out by the store-room clerk. The cards may be printed as shown in Fig. 2. When any stock article is required to fill a shipping order, and this article is not in stock, the store-room clerk makes out a slip or list showing what is needed and for what shipping orders. These data are then classified and entered on the cards, so that upon receipt of the stock, the number of pieces required for various shipping orders may be correctly distributed. It is well to place on the card the shop working order number on which the stock is being made, in order to readily locate the goods in the shop.

A daily report sheet is necessary, as shown in Fig. 3. These should be made up in pads, and every department supplied. Each day the foreman or his clerk enters in their proper columns the working order numbers which he sends away, and the number of the department to which he sends them. These reports should be dated and turned in every night to the head of the follow-up system. From them the "follow-up man" enters a report on his tracer cards. (See Fig. 4.)

These cards are filed numerically according to the working order numbers, and may be used either for special or stock orders. Of course, in the case of stock orders the customer is "Stock," and there is no shipping order number. These tracer cards are made out from the working orders before they go out into the shop. If kept up to date, it is possible to tell at a glance where any particular working order is located, and on what date it went to the department where it then is.

We are now in a position to assume a case and see the working of the system in detail.

1. A customer sends in an order, duly numbered, for some stock article. This order is first examined to see if everything is clear, and is then given a shipping order number. If customary, a regular shipping order form is made out. The order should then be entered on the proper card in the customer's card index, Fig. 1. The customer's order number is placed in the first column, and the shipping order number in the second column, as explained before. If a regular shipping order form has been made out, the customer's original order may be filed away, otherwise it must go to the store-room to be filled. We will suppose the goods ordered are on hand and that the shipment occurs immediately. The following day all shipments are stamped on the customer's cards in the last column opposite the proper number. Now, as often happens, the customer sends in his inquiry directly after his order. This inquiry comes to the "follow-up man," and he turns to the correct customer's card and sees that shipment was made on such and such a date.

2. Now let us suppose an order was received for some special goods. The entries are made exactly as before, but shipment cannot, of course, be made directly. A working order is now issued for the goods wanted, and its number is noted on the shipping order, and this latter is filed away temporarily according to its number. Now comes the inquiry. The "follow-up man" turns to his customer's card and sees that shipment has not been made. He then notes the shipping order number on the inquiry, and gets this shipping order from its temporary file. Then he can readily see that the goods are special, and are in the process of manufacture. By means of the working order number he can locate the tracer card for that particular order, and this tracer card has a complete record to date of the order in question, and shows in which department it is. It is now necessary for him to make out a card as shown in Fig. 5. In the column headed "last reported" he enters the latest report as shown by his tracer card. The working order number, shipping order number, customer's name, and a short description of the goods are also entered in the spaces provided. This "estimate card" may then be clamped to the order and inquiry, and when the "follow-up man" is ready, he takes these inquiries and looks up the work in the department in which it was last reported. From the foreman of that department he obtains a promise as to when his work on the goods will be done. He must enter the date of this promise on his estimate card in one of the "promised" columns opposite the name of the department making the promise. This promise should also be recorded by the foreman in a book suitably indexed for the purpose of enabling the foreman to lay out his work in such a manner as to be best able to keep or anticipate his promises. When he has obtained all the promises desired, the "follow-up man" may return to his desk and enter in his "estimate" column the dates on which he estimates the work should leave the various departments through which it has yet to go. From the estimated date of delivery of the goods to the store-room he makes a promise which he enters on his estimate card, on the customer's inquiry, and also on the tracer card for that particular order number.

ORDER TRACER

DATE:

CUSTOMER:

WORKING ORDER NO.:

SHIPPING ORDER NO.:

DESCRIPTION:

PROMISED:

DEPARTMENT		DATE
ORDER DEL'D		
CUTTING OFF DEP'T.	1	
PLANING DEP'T.	2	
TURNING DEP'T.	3	
SCREW MACH. DEP'T.	4	
MILLING DEP'T.	5	
THREADING DEP'T.	6	
BORING & DRILLING DEP'T.	7	
HARDENING DEP'T.	8	
GRINDING DEP'T.	9	
ASSEMBLING DEP'T.	10	
INSPECTION DEP'T.	11	
STORE ROOM	12	

Machinery, N.Y.

Fig. 4. Tracer Card which gives the Location of any Particular Order.

The "estimate card" is now filed in a specially prepared index as shown in Fig. 6. It is filed under the date promised and under the sub-division of the department making the promise. Each day the cards filed under that date are taken out, and the "follow-up man" goes from department to depart-

ment, ascertaining if promises have been kept, and if so, getting a new promise from the next department. This will prevent an inquiry from ever being forgotten, and it is easy to see whether a promise to the customer will be lived up to or not.

3. Last of all we have the case where the customer orders regular goods, but these are not in stock at present. After the usual preliminaries, the store-room clerk makes out his shortage list, which is afterwards transferred to the shortage card file, the shipping order being placed in the first column, and the number of pieces wanted in the second column. The inquiry now comes in and goes, as usual, to the "follow-up man." As before noted, he obtains the correct shipping order

ESTIMATE CARD

PROMISED:	DEPARTMENT	ESTIMATE	LAST REPD	LOOK UP	PROMISED 1	2	3
WORKING ORDER NO.	CUTTING OFF DEP'T.						
	PLANING DEP'T.						
SHIPPING ORDER NO.	TURNING DEP'T.						
REMARKS:	SCREW MACH. DEP'T.						
CUSTOMER.	MILLING DEP'T.						
	THREADING DEP'T.						
DESCRIPTION.	BORING & DRILLING DEP'T.						
	HARDENING DEP'T.						
	GRINDING DEP'T.						
	ASSEMBLING DEP'T.						
	INSPECTION DEP'T.						
	DEL. TO STORE ROOM						

Machinery, N.Y.

Fig. 5. Estimate Card which enables an Approximate Date of Shipment to be given.

by means of his customer's cards and then notes what stock is needed to complete the order. Next he looks to his shortage list, where he finds the particular shortage in question duly entered, together with the working order number on which the stock goods are being produced. He will then make out his estimate card and treat this stock order just the same as a special order. A promise once made on a stock order will answer for all inquiries for these particular goods. In other words, there is a record of the probable time of completion of certain stock goods, and these goods are being systematically hurried through the shop by means of the estimate card, which comes up automatically at the time the goods should leave any department.

It has been found that a typewritten list of all stock orders needed to complete shipping orders is a most valuable detail, and should be distributed to the various departments, as it will enable the foremen to direct their work in the proper

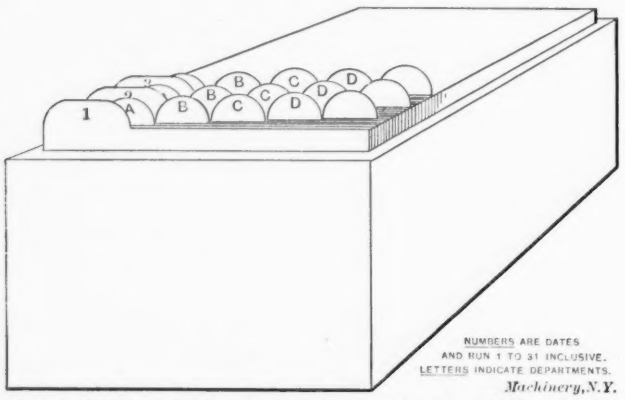


Fig. 6. Estimate Cards filed under promised Date of Shipment, and under Sub-division of Department doing the Work.

channels, and get the goods well under way before an inquiry is received. This list can be made out at regular intervals, say once a week. Another helpful little adjunct will be found in a small paster of any form or wording desired, which should be attached to all orders that are being followed. This paster may simply have the word "Rush" or "Promised" printed upon it in large type. It will facilitate the progress of the work, and give no excuse for its being laid aside because it was not thought to be urgently needed.

Another paster having the word "Shortage" printed upon it can be supplied to the various foremen to paste to any orders in their department which are not being followed, but which, according to the weekly shortage list, are needed to complete shipping orders. Some form of paster is also desirable to attach to the customer's inquiry, on which to enter the shipping order number and the promise. In the accompanying engraving all cards are shown half size.

With these few forms it is easy to answer inquiries in shops receiving fifty to a hundred orders daily. Where fewer orders are received, the number of forms can be cut down slightly. The system is capable of infinite expansion for very large shops.

To any manager whose mail contains complaints which are annoying, a remedy such as above suggested will not only give him immediate rest from the annoyance, but tend to increase his business.

* * *

A PRACTICAL PROBLEM FOR ENGINE DESIGNERS.

We take a great interest in your valuable journal, and as we have noted that you encourage your readers to send problems which they want solved, we wish to propose the following for general consideration.

The problem is to design a new method of controlling the movement of poppet valve reciprocating steam engines. Fig. 2 shows the ordinary plain construction of poppet valve, operated by a cam on a longitudinal lay shaft. This valve has a fixed movement, always opening to its maximum extent. Fig.

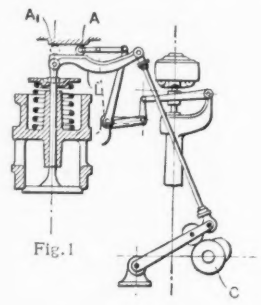


Fig. 1

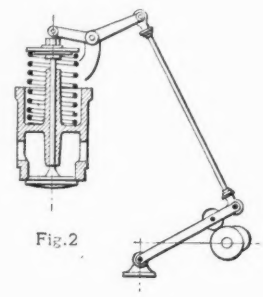


Fig. 2

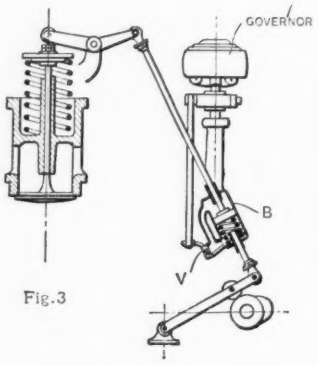


Fig. 3

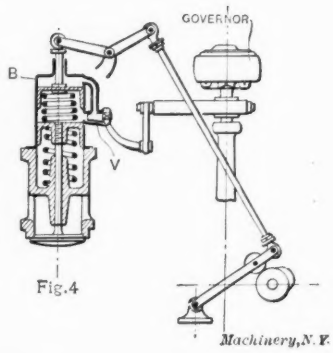


Fig. 4

Machinery, N.Y.

1 illustrates a method for obtaining a variable movement, the variation extending from the maximum to zero, and the operation being controlled by the governor. The construction is quite plain. The little roller A, whose position is controlled by the governor through suitable linkage, acts as a pivot on which the lever L rocks. When the engine is running slow, the position of the roller A is as indicated in the full lines. When the engine is running above full speed, the position of the roller is as indicated at A_1, the result being that the poppet valve is not opened at all by the action of the cam C.

In Fig. 3 is shown the "extensible bar" method, the construction being that of a cylinder and piston in the valve connecting-rod with suitable by-pass valve V controlled by the governor. The piston is under pressure of a coiled spring and both sides of the cylinder are filled with oil. Fig. 4 shows a variation of the same construction.

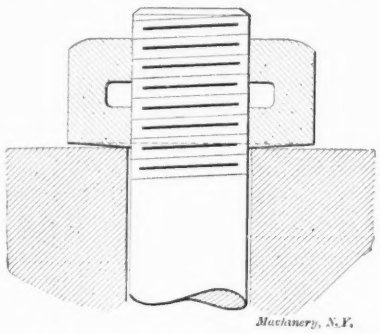
Now, who can get up a different construction which will give variable opening of the valves with delicate governor control?

SOCIETE ANONYME DES MOTEURS A GAZ A BOLLINCKX.
Huyssinghen, Belgium.

ITEMS OF MECHANICAL INTEREST.

SIMPLE FORM OF LOCK NUT.

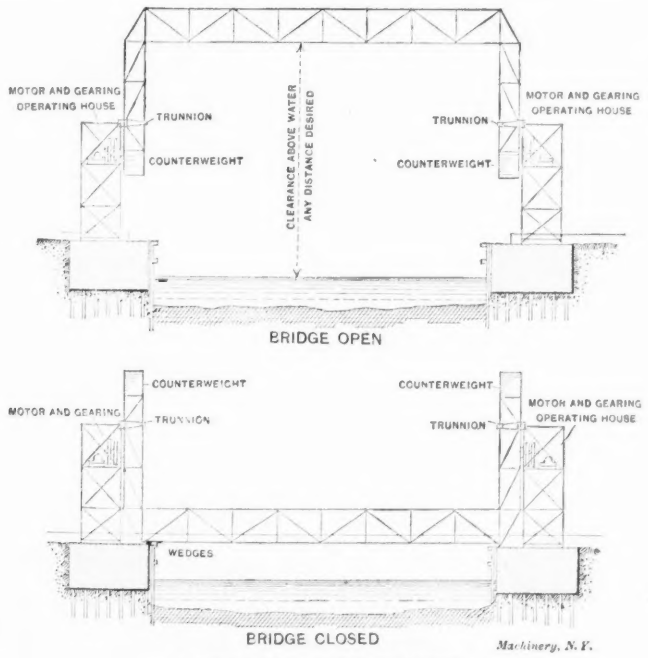
A new form of lock nut, interesting chiefly on account of its simplicity, was illustrated in the February 7 issue of the *Practical Engineer*, and is shown in the accompanying engraving. This construction of lock nut has recently been proposed by some English inventors, Messrs. R. R. Wellbury, T. Harle and G. Mackie. Most of the lock nuts patented from time to time, though fulfilling their purpose successfully, have been expensive to manufacture, and have been accompanied by difficulties in fitting. The nut shown here is free from these objections. The lower face of the nut is faced slightly conical, as shown, and an annular groove is formed inside the threaded hole, allowing a certain amount of elasticity between the upper and lower portions of the nut. When used, the inside area of the lower conical face is the first part to come in contact with the work, and, owing to the elasticity allowed by the annular groove, further tightening forces the lower threads of the nut into close frictional contact with the threads in the bolt, thereby preventing any slackening back or shaking loose of the nut. It is stated that a number of these nuts have been applied to high speed steam engines, traction engines, motor cars, etc., and have proved very satisfactory.



Inexpensive and Simple Form of Lock Nut.

AN INTERESTING DRAW-BRIDGE.

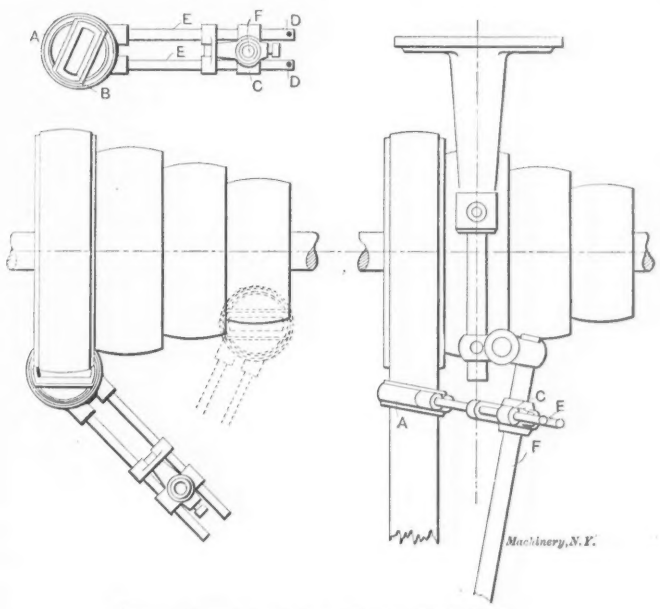
A draw-bridge of novel type has recently been designed by Mr. Eric Swensson, of Minneapolis, Minn., with the intention of applying the design to a bridge across the "Narrows" on Lake Minnetonka. The principle of the construction is shown in the accompanying engraving, taken from the *Engineering News*. The construction is so peculiar that a brief description may be of interest. The bridge consists of a truss or plate girder span, suspended by trussed hangers from trunnions bearing on towers at each abutment. The draw is opened by revolving the truss in an arc around the horizontal longitudial axis through the center of the trunnions, as is clearly indicated in the engraving. The upper portion of the trussed hangers carries counterweights equal in weight to the suspended structure, so that the friction and the wind pressure are the only forces which the machinery has to overcome in opening the bridge. When the bridge is in its normal condition wedges are placed under the extreme ends, so that the weight is carried directly by the abutments, and not by the trunnions.



A Draw-bridge of Unique Design.

GERMAN TYPE OF BELT SHIFTER.

An interesting, and for its purpose, well adapted belt shifter, which has been in use in Germany for some time past, is shown in the accompanying engraving. This belt shifter is made by the Berlin-Anhaltische Maschinenbau-A.-G., Berlin, and is known by the trade name "Bamag." As shown in Fig. 1, this belt shifter consists of a casting *A*, into which the belt guide *B* is fitted so that it can turn freely in the hole in *A*, in order to adapt itself to the belt in the various positions of the shifter. Into the casting *A* are inserted two rods or shafts *E* of such a length as to accommodate the required motion of the belt guide *B*, in relation to the holder *C*, in which the two rods *E* have a sliding fit. The small stop pins *D* prevent the shafts *E* from entirely sliding out of the holder *C* when the device is in operation. Through the hole *F* in the holder *C* the shifting rod, which is made of cold rolled stock, is passed, and the shifting is accomplished by turning this rod, a pin or handle being attached to it at the lower end for this purpose. When the shifter is applied to cone pulleys, the belt guide *B*, containing the belt within it, will adapt itself to such a position that the belt will run freely, the adjustment of the part *A* containing *B* being accomplished by the sliding action of the studs *E* in the body *C*.



Figs. 1, 2 and 3. German Type of Belt Shifter.

The engraving, Fig. 2, shows a plan view of a case where the belt shifter is applied to a cone pulley. Fig. 3 shows the connection of the belt shifter with a bracket on the ceiling and shows the general arrangement of the device. The connection with the ceiling bracket support is a universal joint, permitting perfect freedom to the motion of the shifter rod and shifter. It is difficult to judge from the engravings to what extent this shifter is practical, but we understand that as many as 14,000 are in use on the European continent, and the Krupp works alone use over 600. This would indicate that the device has proved to be thoroughly practical. The Brown & Sharpe Co. employs in its shops a belt shifter working on a similar principle, although even somewhat simpler; this shifter gives entire satisfaction.

* * *

In the construction of a battleship, the exact weight of every part, and of every accessory, from a doily on the captain's table to the heaviest piece of armament or mechanism, is ascertained and recorded, thus making it possible to determine the weight of the ship at any stage of the construction. The importance of weighing everything will be appreciated the more when it is known that the weight of the paint alone, used on the battleship *Connecticut*, amounted to 210 tons.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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JUNE, 1908.

PAID CIRCULATION FOR MAY, 1908, 22,426 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

HUNTING FOR WORK.

During the present depression thousands of men, skilled and unskilled, are engaged in the almost hopeless task of looking for work. They spend money and energy in about the most discouraging task a human being can engage in. Rebuffed at every turn, there is great danger of a man's moral fiber being so deteriorated that his former good habits are lost. Such periods make tramps and hoboes, and a skilled man should be very careful how he starts out in an aimless search for employment. It is hard, of course, to sit quietly at home when want is staring you in the face, but what is the use of making a bad matter worse? The cheapest and generally the most profitable way for a skilled man to find out where employment is to be had is to write letters to all the concerns within a radius of, say, one hundred or two hundred miles, stating his experience and asking for employment. When no work is to be had, such letters, of course, cannot bring employment, but they will most likely be placed on file and referred to when openings do develop. A personal interview is always preferable, but when "nothing is doing," superintendents will not entertain applicants, or even go to the trouble of taking their names. The letter puts on file the very data that may give you a job long before the other fellow, who depends on a personal canvass, gets one. It is better, nine times out of ten, to stay at home and help the wife clean house, tend the baby and do the cooking. You will have time also to study mechanical drawing and other matters connected with your trade, knowledge of which may advance you rapidly when good times come.

* * *

BUILDING SHOPS FOR GROWTH.

It is a matter of first importance in building a machine shop to arrange for future growth. We recently visited an old shop which had grown to considerable size by repeated addition made in piece-meal fashion, the result being a shop having no system of arrangement, and which is poorly lighted and badly arranged for the manufacture of its product. It was impossible to provide adequate overhead appliances for handling the work, and in consequence this shop, although well located in many respects, cannot compete advantageously with other shops having modern equipment, so that it has become necessary to put up a new structure having cranes and handling appliances. It is, of course, needless to say that the new shop will be constructed with an eye toward possible extension which can be added in harmony with the original plan.

The saw-tooth roof shop is admirable in this respect, it being possible to add to it indefinitely in harmony with the original unit, and still have a shop that is well lighted in all parts. A monitor roof shop with saw-tooth roof wings can be extended indefinitely, also, and the combination is well adapted to both heavy and light constructions. The monitor roof shelters the heavy traveling crane and heavy erection, while the saw-tooth wings shelter the machines and small erection floors, these latter being provided, desirably, with light hand traveling cranes.

* * *

FOREIGN MACHINE TOOL COMPETITION.

With apparent good reason, many of our American machine tool builders have felt that foreign trade was largely a matter of the past. Europe has an army of educated engineers—men who rank higher in technical attainments and training than the same class here. They have highly developed powers of analysis and are quick to grasp the fundamentals of a given proposition. They excel in the metallurgical arts and are most thorough in general application. Europe's manufacturers are long-established, and the inherited skill of many generations of workmen is at command for moderate wages. With all these resources available in a country where trade is keenly sought, it would seem that the machine tool business must go back into the hands of the native builders.

There is another theory, however, that gives us a crumb of comfort, and it is one that is quite important to consider. It means much to all American manufactures, for, if sound, it may result in giving us the markets of the world. Whether it was developed by a high tariff man we know not, but it does have a measure of plausibility.

The theory is that the machine tool builders of England and Germany cannot develop into strong competitors of the United States for the simple reason that *they have a restricted market.* The rampant militarism in Europe and the trade jealousies fostered thereby, discourage Germans from buying English tools, and *vice versa.* The same holds good with the other European countries all along the line. The colonial trade of none of these countries will call for a large number of machine tools for years to come. Without a large market the machine tool builder cannot specialize, and if he cannot do this he cannot compete with us. The majority of the foreign machine tool builders are "engineers"—that is, they build anything under the sun that will make a penny of profit. If this condition must continue because of the reason we have given, we have a hold on foreign business that cannot be shaken off until military domination is done away with.

However, the influence of militarism and political prejudice is waning, and we are inclined to take the view of Winston Churchill, who started in life as a Tory, but who is now the leader of the younger democratic group in the Liberal party of England. He believes that economic and not political policies will dominate in the future. "The world has become acutely conscious of the fact that political freedom, however precious, is utterly incomplete without a measure, at least, of social economic independence. All over the world the lines of cleavage are ceasing to be purely political, and are becoming social and economic." In trade intercourse, political prejudices will be cast aside, more and more, and the progressive German manufacturer will have no more hesitation in buying machines from English or French makers, which will be money-makers for him, than from his own countrymen. Political prejudice is fostered by ignorance, and the spread of intelligence by the telegraph, telephone, the daily newspaper, the trade journal and the commercial traveler is doing much to prevent war, the bitter feelings engendered by war, and the political prejudices that hinder international trade.

SPECIALIZATION.

The tendency toward specialization in practically all branches of manufacturing develops some curious anomalies, or perhaps we should say some apparently curious anomalies. These, in most cases, are largely imaginary because of the feeling still remaining with most of us that a machine manufacturer constructs his product from the raw materials, that is, from the metals as they are received from the rolling mill, the blast furnace and the smelter. There is no good reason for such opinion, in the first place. Even if there were, a sound definition of "raw material" being impossible, it becomes very difficult to say what work a so-called builder should actually perform to have proper credit for actually manufacturing his product.

Take, for example, the manufacture of sewing machines. It is the most highly organized business in existence, yet we understand that very few sewing machine manufacturers make their own bobbins, practically all the bobbins used in the United States being made by one Chicago concern. Needles and shuttles are made by specialists cheaper, it is claimed, than they can be produced by large manufacturers, because of the ability of an individual to concentrate his powers of organization and inventiveness upon a single subject without interference. In large manufacturing plants it has been found that the development of special machinery is not desirable, and many of our best-known concerns contract with the small concerns for the invention and development of certain special machinery. They have found it more satisfactory both in the efficiency of the machines produced and the cost. This fact betrays a weakness in the organization of large concerns which perhaps means that the small concern will always enjoy certain advantages over powerful corporations.

* * *

WAGES AND THE TARIFF.

It has been often pointed out, although not quite as often, perhaps, as it should have been, that while wages in America are *absolutely* higher than in Europe, they are *relatively* lower in this country, if the amount of product turned out per capita is taken as the basis of comparison. In itself this may be considered as of small consequence; but it is highly significant and of interest to note in connection with the claims made by the defenders of our protective tariff, that it would be difficult, if not impossible, for our manufacturers to compete with European labor if this were a free market, because the wages paid to American labor are higher than those paid in Europe. This argument is fallacious, because for the same amount of product there is less paid in wages in the United States than in Europe. Mr. Clark, in the *Engineering Magazine*, issue of May, 1904, pointed out that while 21.4 per cent of the value of the product went to pay labor and the cost of power in the principal industrial countries in Europe, only 17.4 per cent of the value of the product was used for these purposes in the United States. Power, he says, can be considered as being of the same cost on both continents; consequently, the wages, in proportion to the product turned out, are lower in the United States.

Another indication of the truth of this statement is given by the returns on the coal trade given out by the British Board of Trade. It is shown that the output per person employed in the coal mining industry of the United States, is 560 tons, while in the United Kingdom, the output per person employed is only 280 tons; in Germany, the output is 242 tons; in France, 202 tons, and in Belgium, 159 tons. Now, even if the wages of coal miners in the United States were double the wages paid in Europe, it would follow that the wages as compared with the output, would be the same in the United States and in England; that for Germany the wages would be relatively much higher than in the United States; and in Belgium, in fact, 1.75 times as high. Of course, it is admitted that the coal mining industry presents a case where the difference is greater than in many other industries, but the general tendency is the same in all trades.

The American ability of systematizing and of cutting out useless expense, and the existence of a more contented and intelligent class of workers, has made it possible to produce more per person employed; but it should be distinctly understood that the wages in proportion to the product are lower, and that, therefore, there can be no reasonable fear whatever, that, even with a reduction in the tariff, the lower per capita wages of Europe would be able to force an unprofitable competition on American manufacturers.

* * *

MATHEMATICS AND PRACTICAL EXPERIENCE.

An Eastern machine tool builder, who is a broad-minded and competent mechanical engineer as well, (by no means an unusual combination) remarked the other day that it was the regret of his life that he had graduated as a young man from the technical school which was his *alma mater*, instead of from another whose name he gave, and concerning whose work he was well informed and enthusiastic. In the school he attended, the first importance was, and still is, given to mathematical analysis, the faculty believing that a thorough knowledge of this is the prime requirement for a successful engineering career. As an instance of the kind of instruction given, he mentioned the fact that his text-book on the steam engine was written by a chaplain to Queen Victoria, an estimable clergyman of great mathematical ability, who had analyzed the steam engine problem mathematically, and been rewarded for his labors by the honorary appointment mentioned. He covered the ground of steam engine design quite thoroughly for the time in which he lived, producing what is, perhaps, the most formidable array of formulas on the subject that has ever been assembled. These formulas include an appropriate supply of constants, whose values are not given, as those values can be derived only from experiment and practical experience. The necessity for saying anything about the values of these constants apparently did not enter into the head of the reverend engineer, as he probably believed that the task of instructing students was completed when the analysis and its resulting formulas had been followed and understood.

In contrast with this pedagogical idea, the second school which our acquaintance mentioned so appreciatively, lays special stress on the necessity for bringing analysis and practice into intimate relation with each other. A large share of its laboratory work consists in the commercial testing of various apparatus within its field. Its professors are largely engaged in consulting work, and its president is the head of a famous firm of engineers, and only gives half of his time to the school. Under such conditions as these, the student learns that mathematical analysis is of the greatest importance, but that its importance is the importance of a tool, useful in applying results of past experience and experiment to future design, and in suggesting methods and lines of experimental research into new fields of practice. From a standpoint like this, it will be seen that the chaplain-engineer's neglected constants assume an importance which he did not realize, and his fine spun analysis is left hanging in mid-air, as it were, without any point of contact with the solid ground of practical work.

It was probably due, in part at least, to such an implicit reliance on analysis as would be fostered by prolonged study of the chaplain's text-book, that the engineers responsible for the design of the Quebec bridge disregarded the repeated assertions of the untrained "practical" men in charge of the erection, that the great bridge was unsafe. So confident were they in their knowledge of mechanics and mathematics, that they failed to realize that the signals of distress displayed in the structure had an importance far overshadowing the results of their theoretical conclusions. The *Engineering News* has rightly remarked that perhaps the most profound lesson to be drawn from the Quebec disaster is the lesson of humility for the technically trained engineer. Not humility in the sense that he should think less of his technical training, but that he should think more of the importance of the practical behavior of the materials, structures and mechanisms with which he has to deal.

* * *

The man in charge who is missed when temporarily absent is a bad organizer.—*D. T. Taylor.*

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

In the May issue of MACHINERY we stated that helium had been solidified by a Dutch scientist, Professor Onnes. It seems, however, that Prof. Onnes had made a mistake in stating that he had succeeded in solidifying helium. He has now given out a statement to the effect that his helium contained a slight amount of hydrogen, and that this accounted for the solidification.

The Schlick gyroscope for preventing the rolling of ships at sea has been applied to a small steamer *Silvania* of the Hamburg-American line. The displacement of this vessel is 900 tons. The fly-wheel of the gyroscope is 65 inches in diameter, and will run at a rate of 1,800 revolutions per minute. The results will be watched with considerable interest by marine engineers as well as by mechanical engineers in general.

The tower of the Metropolitan Life Insurance Co.'s building, which is now in the process of construction at Madison Square, New York City, and which is to be the highest structure in the world outside of the Eiffel tower in Paris, is to have another 37 feet added to its original height, bringing the extreme top 693 feet above the sidewalk level. The new design provides for an observation balcony 662 feet above the sidewalk, and including two stories in the basement, the total number of stories will now number 50.

The horse-drawn vehicle is, says the *Horseless Age*, slowly but surely being displaced by the motor car for public transportation in all large cities. In London there were on January 1, 1907, 783 motor omnibuses and 2,964 horse omnibuses, while on January 1, 1908, the number of motor omnibuses had risen to 1,205, and the number of horse omnibuses had decreased to 2,557. The number of motor cabs had increased during the same period from 96 to 723, while the number of horse cabs had decreased from 10,492 to 9,818. There are, at the present time, 1,700 motor trucks in use in London.

An English inventor, Mr. Chas. J. Grist, London, has, according to the *Iron Age*, patented a method of hardening steel or steel alloys. By this process the steel to be treated is heated in a vessel containing mercury heated to a temperature varying for different steels from about 400 to 840 degrees F., and then an electric current is applied at from 200 to 500 volts and 25 amperes. Carbon steel twist drills treated in this manner perform nearly double the amount of work done by drills hardened in the ordinary manner. Inasmuch as mercury vaporizes at 675 degrees F., a temperature of 840 degrees would, however, not be attainable.

According to the *Berliner Lokal Anzeiger*, a course in automobile engineering will be instituted at the technical institute at Berlin. It has been decided to extend the instructions concerning automobile engineering to all its branches, and to render it practical by increasing the laboratory equipment. The cost of machines and testing equipment necessary is estimated at about $60,000, and many expensive machines will be loaned by private firms who will also bear the expense of a great portion of the experimental equipment. The department will be conducted by a professor having a staff of two assistants, two mechanics and a chauffeur.

The best record in high-speed drilling that we know of is that made lately by Baker Bros., Toledo, Ohio, on a special drill press, using a Novo twist drill 1¼ inch diameter. Holes were drilled through cast iron blocks 4¼ inches thick in 8 2/5 seconds, or at the rate of about 29 inches per minute. The drill ran at 450 revolutions per minute with a feed of 1/15 inch per revolution. A peculiarity of this rapid drilling is that the drill is not as hot when it has passed through the block with a feed of 1/15 inch per revolution as when it is run with a finer feed. Allowing that steel plate could be drilled at only one-half this rate, it is of interest to note that even then drilling would be faster than punching 7/16-inch plate on a punching machine running at the rate of 30 strokes per minute!

The highest efficiency as regards steam consumption that has as yet been obtained in any steam engine, has, according to *Industritidningen Norden*, been attained in an engine built by the J. & C. G. Bolinder's Works, of Stockholm, Sweden. This engine is of 1,000 H.P., and at official tests the steam consumption per indicated H.P. hour was only 8.58 pounds. Another remarkable feat in the design of steam engines has been attained with a 100-horse-power superheating portable engine built by R. Wolf, of Magdeburg-Buckau, Germany, which during a 7 hours official trial showed a steam consumption of 8.66 pounds per horse-power-hour, and a coal consumption of only 1.04 pound per horse-power-hour. The lowest steam consumption previously attained with any steam engine is, as far as known, 8.89 pounds, which was attained some years ago by an engine built by a Belgian firm.

In our September, 1907, issue, engineering edition, we mentioned the favorable results obtained with motor-driven fire engines in Hanover, Germany. The city of Berlin also, about two years ago, appropriated $12,000 for the purpose of carrying on experiments to determine the most suitable motive power for fire-fighting apparatus in that city, and the results obtained from these experiments indicate that a great saving can be accomplished by the use of steam and electric automobile fire engines. Gasoline engines are not recommended on account of not being considered absolutely reliable, and also because the danger of gasoline was considered objectionable. In consequence of the favorable results obtained, the Berlin city council has made an appropriation of $32,000 for the acquisition of a complete motor fire engine outfit, consisting of a chemical extinguisher, a tender, a hook and ladder, and a steam fire engine.

A circular from the United States Department of Agriculture calls attention to the significant signs of the awakening of the American people to the dangerous destruction of the forest wealth, and the necessity of a wise use of what remains of it. The question of the limitation of our supply of woods is one that is of great importance to all industries, inasmuch as this material is used in a greater or less degree in all our industrial activities. The circular calls attention to the fact that information on the subject of preserving timber from decay will be furnished to all who make request of the Forester Service of the Department of Agriculture, Washington. The fact is pointed out that it is not only possible to utilize the forests without waste, but also to prolong the service of the wood used so as to thereby decrease the consumption. The life of the wood can be considerably lengthened by the use of certain preserving methods which the department has been investigating.

The saw-tooth roof shop is a very satisfactory construction for the small manufacturer who must "pay as he goes." It is so readily enlarged in harmony with the original lay-out and so cheap in first cost that it is likely to become a very common type of machine shop architecture. The feature of uniform lighting, there being no glare or dark shadows anywhere, is in itself enough to commend it above most other types. Of course, where land is very costly the saw-tooth roof shop must give place to the factory type, having several floors superimposed. A fault of the saw-tooth roof is the difficulty of making the gutters proof against leaking. Hard rainstorms, especially when driving from the north, have caused much trouble with certain concerns, especially if the north saw-tooth windows were glazed with small panes set in the sash with ordinary putty. The remedy is to use large panes of ribbed glass without sash, the glass being set in the frame-

work of the shop, thus avoiding joints other than between the glass and the wood. The Kearney & Trecker shop in Milwaukee is built on this plan, the glass being placed in the openings without sash and set with good white lead putty.

INDICATOR FOR ASCERTAINING HARDENING TEMPERATURE.

An indicator for ascertaining the temperature of steel to be hardened has, according to *Page's Weekly*, recently come into use in Great Britain. This instrument depends on the fact that at the recalescence temperature at which carbon steel should be hardened, it becomes non-magnetic. With the aid of this indicator any kind of carbon steel, but not high speed or alloy steels, may be hardened at much lower temperatures than is commonly done when the temperature is gaged by the eye alone. The gage consists of a permanent magnet held in the hand, the poles of the magnet being prolonged by rods of special metal which remains magnetic at temperatures higher than the hardening temperature of carbon steel. If the pieces of work to be hardened are small, they are held by the magnet itself in the flame for heating the work. They will be attracted and held by the gage until they reach the hardening temperature, and at that time they are promptly quenched. This gage is said to be very accurate, so accurate in fact, that unless the steel is instantly transferred to the quenching bath when heated to the point where it loses its magnetic qualities, the loss of heat during the interval will prevent the piece of work from being fully hardened. It is also stated that it would not be difficult, when using this gage, to harden even the most intricate shapes in ordinary brine. The combined hardness and toughness secured by hardening in this manner is such that many cutting tools—in particular milling cutters —may advantageously be used without subsequent tempering. These gages are manufactured by Messrs. Taylor, Taylor & Hobson, Leicester, England, and they have used them in their tool-room for about two years, and have established a remarkable record. In all of the miscellaneous jobs that have been completed in the tool-room, not a piece has been spoiled by poor hardening, or by the very common troubles of warping and cracking.

MANUFACTURE OF SAND-LIME BRICK.

Many travelers on the New York Central lines between Buffalo and Chicago have noticed the immense sand-hills in northern Indiana, especially near Michigan City. These great moving masses, resembling the waves of the sea and typical of the great elementary force of nature, are almost irresistible in their destructive power. The engineering powers of man can not cope with the march of the drifting sand except as they are directed toward the growing vegetation. The birth of the desert can be directly attributed to the destruction of forests on a sandy tract, and one shudders to think of what the fate of large areas of the United States will be if the destruction of forests now going on is not checked. But this is not what we started to say. The moving sand has been made useful in the manufacture of brick, and brick-yards are so located in certain favored localities that the sand is blown up to them as fast as it is wanted. The transportation of this part of the raw material to the works is done by the wind without cost or effort on the part of the brick maker!

The manufacture of sandstone brick or lime brick is a German industry that has reached great commercial importance in Europe and is one that is rapidly growing in this country, there being two hundred plants that have sprung up in the past five years. A few words on the process may be of interest in this connection. The sand is ground in tube mills and is mixed with crushed lime. This mixture is moistened, pressed into bricks, and dried in large steam cylinder driers of 125 to 160 pounds per square inch, the temperature being that of saturated steam at those pressures, of course. The process is essentially the same as the natural process of forming sandstone, except that the time required is only a day or so against thousands of years by nature's method. The sand-lime bricks are made in a variety of colors, and being very strong and uniform in structure are regarded as a most desirable building material.

NEW DEPARTURE IN THE DESIGN OF HYDRAULIC PRESS CYLINDERS.

Teknisk Tidskrift, April 11, 1908.

A Russian engineer, V. Tatarinov, has designed an entirely new and interesting type of hydraulic press, as shown in the accompanying line engraving, Fig. 1. A detailed section of part of the construction is shown in Fig. 2. The fundamental principle on which the new press is designed depends on the fact that when the diameter of the cylinder is increased, the cross-sectional area increases as the square of the diameter, while the area of the cylindrical walls only increases in the

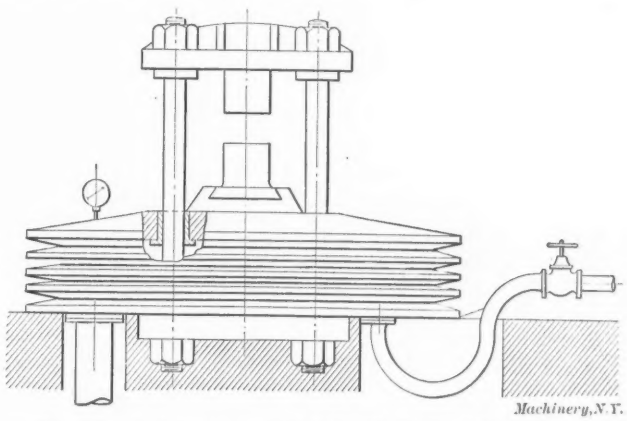

Fig. 1. General Appearance of Hydraulic Press of Novel Design.

same proportion as the diameter. Thus, for instance, if the diameter is denoted $2r$, and the height of the cylinder is supposed to be the unit of length, and the pressure assumed to be the unit of pressure, then the cross-sectional area A of the cylinder equals πr^2 and the area of the cylinder walls Y equals $2\pi r$. Tabulating the results for a few numerical values will best show the variation between the increase of the cross-section area and the area of the cylinder walls for increasing diameters.

r	$2\pi r = Y$	$\pi r^2 = A$
10	63	314
50	314	7,854
100	628	31,416

This table indicates plainly that if the diameter is made large enough, high total pressure can be attained, although the unit pressure on the cylindrical walls will be comparatively low, so that it is possible to use fairly thin walls for the hydraulic cylinders. When the ordinary hydraulic cylinder, however, is made of large diameter, the difficulty of mak-

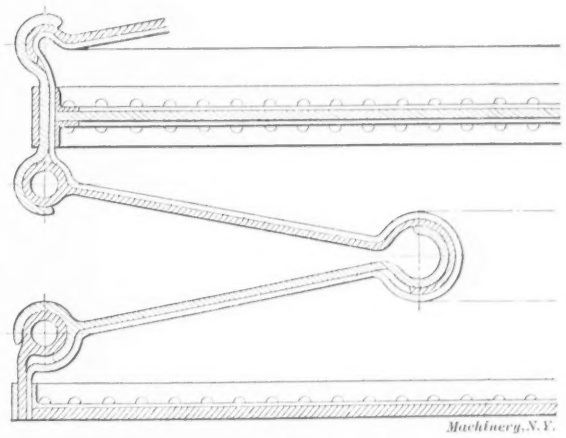

Fig. 2. Detail showing the Design of Elastic Walls in the Hydraulic Cylinder.

ing the pistons becomes very great, and it is practically impossible to make pistons that will work well, with diameters of so large a size as would be required to attain very high total pressures on the pistons without getting any considerable unit pressure on the cylindrical walls.

The next step in the mind of the inventor was therefore to find a cylinder that was so designed that it could work without pistons, the cylinder itself giving the required motions. To accomplish this the walls of the cylinder had to be made elastic in a longitudinal direction. The design of cylinders filling these requirements at first seems to be a more or less

difficult task, but the accompanying line engravings plainly indicate how the problem has been solved. The cylinder, in fact, consists of a large number of shorter cylinders, the cylindrical walls of each one of these simply consisting of plates of metal, joined together, as shown in Fig. 2. This construction permits the lengthening and shortening of the cylinder in a longitudinal direction. It is also evident from Fig. 1 that a comparatively small unit pressure in the cylinder will effect a very high total pressure at the point of action of the press, due to the large diameter of the cylinder on which the pressure acts.

In Fig. 1 the guides or supports, which hold the flexible cylinder in alignment, pass directly through the cylinder, because this permits of a less heavy construction. In a hydraulic press designed as described, it is evident that the circular form of cylinder is not as imperative as in the case of ordinary hydraulic presses, and therefore the section of the cylinder may be either circular or square.

While the present design is rather ingenious and constitutes an entirely new departure in hydraulic cylinder design, it seems that the new construction is not of very great importance, and the making of hydraulic cylinders of this type would be most likely fully as expensive, if not more so, than the making of ordinary hydraulic cylinders and pistons. Besides, the press would work rather slowly, owing to the fact that only low pressures would be used and a large volume would have to be filled with the fluid before action would take place.

FRENCH SELF-TIGHTENING AND QUICK-RELEASING DRILL CHUCK.

La Machine Moderne, February, 1908.

We show in Fig. 2 a section, and in Fig. 1 details, of an ingenious automatic chuck for drills, invented by M. Heynan. This chuck permits the insertion and removal of straight shanked drills without stopping the machine, and without the use of a key or wrench of any kind. Referring to the assembled view and the details, the gripping surfaces are a series of rollers, *A*. These rollers are each composed of three disks, formed integrally with the spindles of which

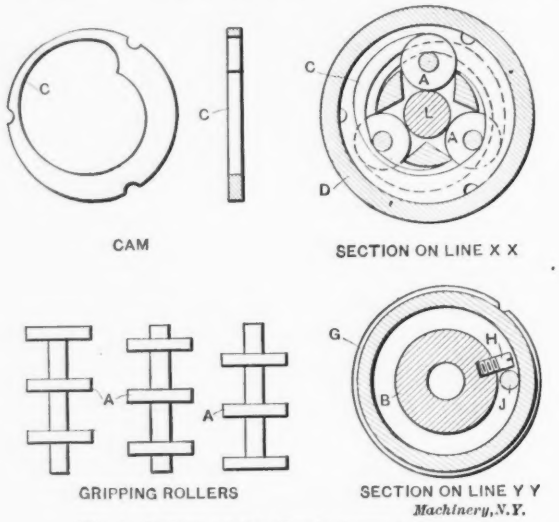

Fig. 1. Details of the Chuck shown in Fig. 2.

they are a part. They are arranged in the body *D* of the chuck, bearing on the outside on the inner surfaces of cams *C*, while their inner edges are in position to grip the work. There are nine cams in all, one in position to engage each of the three rolls of each of the three spindles. These cams *C* are keyed to a sleeve *D*, which is in turn screwed and doweled to a collar *B* on the shank *G* of the chuck. By means of the shoulders shown, parts *D* and *B* may be revolved freely on *G*. Screws *J* in *B*, and *H* in *G*, however, limit this movement. A coiled spring *F*, in the recess shown, tends to revolve *D* in a clock-wise direction. The nine cams *C* (see the upper right-hand view in Fig. 1) are keyed to *D*, so the spring tends by the action of the cam surfaces, to force rolls *A* inward. Cams *C* and rolls *A* are simply slipped into place from the bottom of the chuck, and are retained by cap *K*, which screws over the nose of sleeve *D*.

The operation of the chuck will at once be evident. As it is revolving in the direction required for right-hand drills, sleeve *D* is grasped by the hand, thus stopping its rotation until screws *J* and *H* have been brought up against each other. When this happens, the parts are in the position shown in the section on line *X X*. Centrifugal force throws the rolls *A* outward, leaving the full diameter of the chuck for the insertion of the drill. Drill *L* is then inserted and sleeve *D* released. Spring *F* revolves it in a clockwise direction, forcing rolls *A* into contact with the drill, thus holding it tightly. If the drill should slip under the pressure of the work, it will only cause rolls *A* to revolve, turning cam *C* further in the direction in which it is urged by the spring, thus holding the drill all the more tightly. Since, however, only a very slight turning moment is required to hold the drill firmly, it is easily released, even when the chuck is revolving, by simply grasping the sleeve as before, until the rolls have been loosened and screws *H* and *J* have been brought up against each other so that the parts are expanded to their fullest extent.

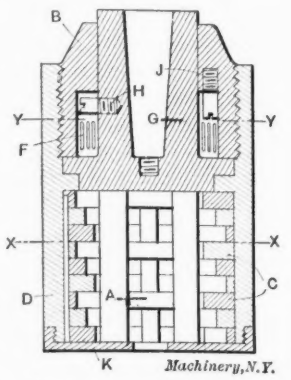

Fig. 2. A Chuck which automatically grips the Drill and automatically tightens if Slippage occurs.

ECONOMY OF HIGH SPEED PLANERS.

Times Engineering Supplement, March 18, 1908.

The first makers of planers contented themselves with giving the idle stroke a speed double that of the cutting stroke, so that, instead of 50 per cent of the time being expended in the idle stroke, as would have been the case were it speeded at the same rate as the cutting stroke, only 33 per cent of the time was so expended. In these early planers no serious amount of energy was dissipated at the time of reversing, because the rate at which the planing was done rarely exceeded 20 feet per minute for cutting and 40 feet per minute for returning. High speed steels, however, have rendered it practicable to cut at a speed of 60 feet per minute, and even if the old ratio of return to cutting speed were not exceeded, the idle stroke would be at the rate of 120 feet per minute.

The energy of a moving mass, however, increases as the square of its velocity, so that whatever dissipation of power there was in the old-time planer, having a cutting speed of 20 feet, the amount dissipated at a speed of 60 feet per minute will not be three times as much, but nine times. It is this circumstance that has made the planer a more difficult subject than the lathe to properly adapt to high speed steels. If the lathe is speeded up threefold, it takes three times as much power to drive it, and it turns out three times as much work, but the power consumed per unit of work remains the same as before. The planer, however, speeded up in the same ratio, dissipates energy at each reversal nine times as great as before, and becomes consequently seriously extravagant with power. It is interesting to note what this waste amounts to. It depends, of course, upon the number of reversals made per minute, and the masses which have to be reversed. A medium-sized planer, with table and work weighing 10 tons, consumes each time the table is stopped or started at the 60 feet per minute cutting speed, power equal to 0.3 foot-ton, and each time the table is stopped or started at 120 feet return speed, power equal to 1.2 foot-ton. This, however, does not include all the energy lost, if the table is driven by gearing revolving at high speed, which also has to be reversed. While these parts may be comparatively light, many of them run at a far higher speed, and as the energy is proportional to the square of the velocity, the power consumed in stopping, starting and reversing these parts is often twice as much as that required for reversing the table itself. If this loss is reduced by the slipping of belts or friction clutches, it is reduced at the expense of time, but if the belts are sufficiently powerful and driven by an electric motor, the

violent fluctuation in the demand made on the motor is plainly visible by the use of a suitable recording wattmeter.

Several schemes have been proposed to save this waste of power. One scheme is to use regenerative springs, which are analogous in their action to the recoil springs on a disappearing gun mounting, and these springs receive the energy of the moving parts in retarding, and restore whatever energy they receive in accelerating these parts in the reverse direction. Other schemes for solving this problem have been the use of hydraulic pressure, which stores the energy in the accumulator at the end of one stroke, where it becomes available without loss of power for imparting energy to the return stroke. Electricians have also arranged to drive planers with reversing motors, on the theory that when the currents are reversed at the reversal of the table, the motor becomes a dynamo, and aids the prime mover in mitigation of the excess of demand upon it for accelerating the motor in the reverse direction. Neither of these two last systems, however, has been carried out over as great a range of speed as the system of spring balancing. There are now a considerable number of spring balanced machines at work in Great Britain, which have return speeds as high as 180 feet, and forward speeds as low as 20 feet, or a ratio between the forward and return speed of 9 to 1. In such a case the idle time is reduced to about 10 per cent of the total time, and, if one may assume that the planing machine while cutting is 10 per cent more efficient than other machines on which the same class of work can be done, there could be no economical reason against its extended use.

It is conceded that the straight-line motion of the planer produces a truer surface than the angular motion of revolving tools, and by the use of high speed planers, there seems to be little doubt that more stock can be removed per unit of power by planing with strongly held, stationary cutting tools than with tools revolving on spindles with running fits.

HISTORY OF CRANE DESIGN.

Alton L. Smith, in the *Journal Worcester Polytechnic Institute*, January, 1903.

The lifting and transporting of great weights has from the beginning of history taxed the ingenuity of mankind. The achievements of the engineers of ancient Egypt, in moving and erecting the enormous masses of stone embodied in their colossi, obelisks, temples and pyramids, for a score of centuries, has provoked the admiration and wonder of travelers. While the methods they employed for transport may be understood from the numerous extant tomb paintings, the apparently more difficult operation of erection has never been explained. The fact that no picture of such an undertaking has been found would seem to indicate that the ancient engineers did not regard such feats as of sufficient importance for record. Plausible suggestions are that the elevation of these massive stones was effected either by the use of an inclined plane of banked earth, or by means of levers and some system of blocking.

Vitruvius, writing just before the beginning of the Christian era, describes a lifting device used by his contemporaries which is easily recognized as our sheer-legs with a primitive windlass and pulley block tackle. He also describes another device similar to our guyed derrick but without a boom. This was for lifting very heavy weights and the motive power was supplied by men walking inside a large drum or treadmill which, as it revolved, wound the rope on the windlass. An antique relief preserved in the Lateran Museum at Rome shows such a machine with an inclined guyed mast. The upper block is attached to the head of the mast and the treadmill is filled with young boys. A civil engineer, writing eighty years ago, mentions this form of motor as being recently in use and speaks of the terrible accidents which sometimes occurred when control of the load was lost. The load, descending, would cause the drum with its occupants to revolve at frightful speed.

Little is known of the details of lifting machines employed during the middle ages, but from the scanty records available it appears that the builders of this period made use of a variety of lifting jacks, sheer-legs, the derrick with swinging boom and the under-braced swing-crane. The multiplication of power seems to have been obtained generally by pulley blocks rather than by gear trains.

Up to the time of the introduction of the steam engine, the principal uses of hoisting machinery were for building construction, mining, quarrying, shipbuilding, dock and warehouse purposes, naval and military engineering. The moving and mounting of heavy cannon, particularly, seems to have brought out a large number of lifting devices.

The first part of the nineteenth century teemed with industrial possibilities. During this time steam power had been applied for hoisting purposes and found to be more economical than hand power, but not until about 1850 does there appear a traveling crane actuated by steam power. This was a typical overhead traveler of 10 tons capacity with a steam engine and boiler on one end of the bridge. The various movements of lifting, traversing and traveling were accomplished by means of gearing and clutches. About this time also, Fairbairn's design of a tubular revolving dock-crane was accepted by the British Admiralty. It proved so satisfactory in service that it has persisted as a type until recent years.

While the engine-driven traveler was satisfactory for use out-of-doors and in foundries and forges, the smoke and stifling fumes from the soft coal made it unsatisfactory for other industrial works. The cost of labor, however, did not exert sufficient influence to produce a better machine until about 1861 when Ramsbottom perfected his "flying rope" system for shop cranes and applied it successfully to a traveling jib crane at the Crewe (England) Locomotive Works. In 1864 this type of drive was successfully extended to several 25-ton overhead travelers at the same works and effected an important saving.

From this date forward, power cranes began to appear with increasing frequency until twenty-five years ago they were found in great variety both as to form and motive power. Fixed cranes were operated by compressed air, steam or water pressure, while travelers were driven by high- or low-speed ropes of cotton, hemp or wire, by square shafts or by engines located on the crane itself. Capacities had also greatly increased, going as high as 30 tons for floating cranes, 50 tons for overhead travelers, 60 tons for steam jib-cranes and 70 tons for steam dock-cranes. Many of these types had reached the general form which they present to-day, changes since then having been largely due to the substitution of steel for the wood, cast iron, iron forgings and structural iron then employed. A 2½-ton wrecking crane, described by a writer in 1874 as "very powerful," throws an interesting side light on the rolling stock of that time.

The date of the advent of the first commercial electric overhead traveler is uncertain, but the first of which published record is found was in operation in a foundry at Bourges, France, about 1883. It had a capacity of 20 tons and a span of 50 feet, the power being furnished by a single motor. The various movements on these early single motor cranes were obtained by means of clutches and gearing. At the Paris Exposition of 1889 two 10-ton single-motor travelers were installed by the management, chiefly, it would seem, as objects of curiosity. There was also exhibited at this time a traveling hoist of small capacity equipped with two motors, one for lifting and the other for traveling.

Many single motor travelers were brought out in the next two or three years, but the hesitation with which they were accepted is indicated by the fact that of four 150-ton travelers put in operation at about this time in England and the United States, one was driven by an engine and boiler placed on the crab or trolley, while the other three were square-shaft driven. A three-motor electric traveling crane built at the shops of the Edward P. Allis Co., of Milwaukee, Wis., after a design by Mr. A. J. Shaw, one of their engineers, was probably the first commercial machine of this type installed in America, if not in the world. This was in 1889.

The perfecting of the series motor and its controller for street railway service soon put an end to general demand for the single-motor, square-shaft and flying-rope systems of driving. One manufacturer of electric travelers states that "within six months of the completion of our first successful crane,

inquiries for other styles of construction had practically ceased." In the square-shaft system the unavoidable use of tumbler bearings and the dependence on gravity to hold the shaft in place, did not permit a very high speed of rotation. If the capacity of the crane was large, then the driving gear had to be heavy and clumsy or else the speed for the various operations had to be slow. This method of driving has apparently become obsolete.

In the flying-rope system the troubles and expense incident to the frequent repair and replacing of the rope prevented its general adoption outside of Great Britain where conditions were more favorable to its use. While our conservative cousins buy the single-motor and flying-rope travelers to some extent, they have practically gone out of use in this country. It is recalled, however, that there is at least one manufacturer of each type here in the United States to-day.

For more than ten years the traveler employing a separate motor for each movement has demonstrated its superiority over the older types. The motor in most common use is the enclosed type direct-current series motor. The induction motor has been successfully used by German crane builders for a number of years, but while its adoption has been urged by some American engineers, it has not displaced the direct-current series motor to any extent. The latter has proved very satisfactory for crane service, and in some new installations where alternating current is employed the expense of rotary converters has been added to avoid induction motors for the cranes. If the altenating-current series motor recently introduced for railway service proves as reliable as present experience indicates, it should displace the induction motor entirely for crane work and make an alternating system just as satisfactory for crane service as is the direct current.

The maximum load capacities of power cranes have been gradually increased until at present the limits are about as follows:

	Tons.
Dock Cranes	150
Floating Cranes	150
Foundry Jib Cranes	50
Locomotive Cranes	50
Overhead Travelers	150
Wrecking Cranes	100

It is a significant fact that most of the very large cranes produced at any one period during our industrial development have been made necessary by the requirements of naval armament. Twelve-inch rifles weigh about 58 tons, while the turn-table and gear for the barbette in which they are placed will weigh about 125 tons. So, too, the machines used in the production of modern armor plate must be served by cranes which can handle ingots of 125 tons or more. But large cranes are also needed to handle what may be called peaceable material such as locomotives and parts of large stationary engines and electric generators. The boilers of the *Mauretania* weigh about 110 tons each and the weight of her low-pressure turbine rotor is 126 tons. If the competition continues between Great Britain and Germany for the domination of the Atlantic ferry, we may look for still larger cranes in the near future.

The first of the very large dock cranes was installed at Bremerhaven in 1899. Since then they have sprung up like toadstools in the shipyards of Germany and Great Britain, being mostly of German manufacture. Great Britain seems now to have waked up to the situation and during the first six months of 1907, six cranes of 150-tons capacity each have been installed at various British works. Three of the six were made necessary by the two new Cunarders.

The economy of a crane for handling material has long been recognized in Germany and France. In this respect Great Britain and the United States have been more backward. About fifteen years ago the great German industrial movement began, and their crane industry shared the general stimulus with the result that Germany probably leads all countries to-day in the diversity and capacity of her output. In 1905 the factory department alone of the Krupp Works employed 591 cranes. In the United States the principal production has been overhead travelers and in this type our manufacturers are leaders. Cantilever and Gantry cranes for handling medium and light loads over large areas has also been an important product of American genius. The powerful machines for rapid handling of coal and ore at the ports on the Great Lakes are distinctively American ideas and they have had a most important bearing on our recent industrial activity. The heavy rolling stock and frequent accidents on American railroads have operated to bring out a powerful and efficient 100-ton wrecking crane.

* * *

PIPE BENDS.

WM. F. FISCHER.*

In the modern power house steel pipe bends of large radius are nearly always used in preference to steel or cast iron fittings. There are several very good reasons for this. In the first place, using bends in preference to fittings does away with many extra joints which are liable to cause leakage, and which are, in many cases, a constant source of trouble, requiring the renewing of gaskets, etc. In the second place, in steam lines or water lines of high temperature, the steel pipe bends provide a ready means of taking up expansion and contraction, and it is customary to use special bends for this purpose, known as expansion bends. In the third place, steel pipe bends permit the elimination of many steel castings. The cost of bends is less, and they can be delivered quicker. They also give a neater appearance to the engine-room, in general, than it has when covered with fittings. The weight is also less, and owing to the large radii to which the pipes can be bent, they reduce the friction of the fluids conducted inside of them to a minimum.

The process of bending is as follows: One end of the pipe to be bent is first plugged. The pipe is then filled with sand, which is packed tightly, and the other end of the pipe is capped. The pipe is then placed in an oil-heated furnace, and the portion to be bent is heated to a red heat. It is then taken out and placed on the so-called bending table, which is made of cast iron and securely bolted to a heavy foundation. This table is flat, and is cored all over with holes, spaced about six inches apart. Circular steel pins are inserted into these holes. The pipe is clamped between two or three pins, and bent around other pins set so as to give the required radius. A rope is attached to the end of the pipe, and the bending is accomplished by pulling this rope with a winch or other suitable means.

After the pipe is bent to the required shape, it is cooled by running water with a hose over the heated portion. The purpose of the sand filling is to prevent the pipe from flattening when bending, which would necessarily occur in large pipes if they were not filled and well rammed down before bending. Should it happen that after the pipe has cooled off, it is found that it does not agree with the required measurements, it can be reheated and again pulled into shape. A man well experienced with pipe bending can, in most cases, bend a pipe to within ¼ inch, or even ⅛ inch, of the required dimensions. If the bends are made even as much as ½ inch or ¾ inch off the correct dimensions, they are quite easily drawn into position when erecting, at least if the line is of ordinary length, say 40 feet or more.

Large sizes of pipes, say up to 6 inches diameter, are very often bent by machine. A templet should first be provided by bending a round iron rod and carefully measuring it, until the right radius and dimensions are obtained. This templet is then placed over the center line of the pipe, as a guide in bending to shape.

As regards the kind of pipe to use, it should be of good quality standard steel or wrought iron pipe, full weight or extra heavy. Lap welded pipe should be used in preference to butt welded, as butt welded seam is liable to open up under the stress of bending. The welded joint should be placed directly over the center line of the pipe, along what might be called a neutral section, so that the joint will be neither in tension nor compression. This prevents the seam from being strained to any extent when bending.

Large pipe from 12 to 20 inches in diameter is liable to buckle on the compression side, especially if bent to a short radius. To prevent this, the radius when bending large sizes

* Address: 392 Second Ave., New York City.

should be made as long as possible. A suitable radius for bending all sizes of pipe from 4 inches to 20 inches diameter, inclusive, is 6 times the diameter of the pipe, and this is known as "standard radius." Bends made with a radius having this proportion to the diameter of the pipe are very satisfactory. Pipe from 4 to 12 inches, however, can be bent, if necessary, to a radius equal to three times the diameter of the pipe, and sizes above 12 inches may be bent to a radius of four times the diameter of the pipe, if required. Even smaller radii than those last mentioned may be employed, but it is not advisable to do so, as it puts heavy strains on the pipe, and is likely to cause buckling on the compression side, even in the smaller sizes.

The length of the straight portion at either end of the bend should be at least equal to the diameter of the pipe, and in pipes 10 inches diameter and upward, it is advisable to make the smallest length of the straight portion equal to 1½ times the diameter of the pipe. If the length of the straight portion is made less than one times the diameter, the pipe is liable to flatten on the ends, which will prevent the flange from fitting tightly, and is apt to cause leakage.

All threads should be cut and flanges put on and made steam tight before bending. On rolled, or Van Stone joints, the rolling, "Van Stoning," and finishing the face must all be done while the pipe is straight, as it would be a difficult task to do after the bend is made.

The Data Sheet Supplement for the present month gives formulas for four different classes of bends. The length of the pipe in the finished bend must be calculated to find out the length of straight pipe necessary. This length, of course, equals the length of the straight portions of the pipe added to the length of each of the arcs. The length of the arc is easily found from the formula:

$$\text{Length of arc} = \frac{3.1416}{180} \times \text{radius} \times \text{number of degrees.}$$

This formula, of course, will be found in this or similar form in all hand-books, and can be easily deducted by simple mathematics. In the form as here given (with the exception of that more decimals are stated for π) it will be found in Kent's Pocket-book.

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CALCULATION OF FANS AND HEATERS.

CHARLES L. HUBBARD.*

The tables and formulas presented in the following, together with the tables which will be found in the Supplement, have been compiled in as concise a form as possible, and will be found very useful in determining the sizes of fans and heaters necessary for special given conditions. The article is not intended to deal with the design or construction of those apparatus; but the data given embody, of course, the fundamental principles on which the design must rest.

Centrifugal Fans.

When a centrifugal fan is in motion, the air in contact with the blades is thrown outward by the action of centrifugal force, and delivered at the outer circumference. A partial vacuum is thus produced at the center of the wheel, and air from the outside flows in to take the place of that which has been discharged. This type of fan is enclosed in a steel plate casing having an inlet opening at the center of the wheel and a discharge outlet at the periphery.

The pressure within a fan casing is caused by the air being thrown from the tips of the blades, and varies with the speed of rotation. In Table I are given the velocities of outflow from a fan outlet into the atmosphere for different pressures within the casing.

TABLE I. RELATION BETWEEN PRESSURE AND VELOCITY IN CENTRIFUGAL FANS.

Pressure in ounces per square inch.	Velocity in feet per minute.
¼	2,585
⅜	3,165
½	3,653
⅝	4,084
¾	4,472
⅞	4,829
1	5,161

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When the outlet from a fan casing is small, the air will pass out with a velocity equal to that of the tips of the blades, and the pressure within the casing will be that corresponding to the tip velocity. The limiting area of outlet at which the velocity of outflow begins to drop below the tip velocity, is called the blast area of the fan. This, for the ordinary form of ventilating fan is approximately $0.14\,D^2$, in which D is the diameter of fan wheel.

The effective discharge outlet of a fan, in practice, is always made larger than the blast area. This, for average conditions, taking into account the contraction of vein in passing through the outlet, may be taken as 1.78 times the blast area, or $0.25\,D^2$.

Capacity Speed and Horse-power of Centrifugal Fans.

The capacity of a fan when operating under a given pressure and discharging into free air is equal to the velocity corresponding to the given pressure, multiplied by the effective area of outlet.

Example: A fan 4 feet in diameter has an effective discharge area of $0.25 \times 16 = 4$ square feet, and when operating under a pressure of ¼ ounce will deliver $4 \times 2{,}585 = 10{,}340$ cubic feet of air per minute.

When the discharge outlet of a fan is equal to the blast area, the tip velocity for any given pressure must correspond to that pressure, as given in Table I, and the speed in revolutions per minute will be equal to the required velocity of outflow, divided by the circumference of the fan wheel. When the effective area of discharge is made larger than the blast area, the pressure for a given speed will drop. Hence, when the effective area is taken as 1.78 times the blast area, or $0.25\,D^2$, the speeds as found above must be multiplied by 1.2 to maintain approximately the same pressure.

Example: A fan 4 feet in diameter has a circumference of 12.5 feet, hence to maintain a pressure of ¼ ounce under actual conditions it must run at a speed of

$$\frac{2585}{12.5} \times 1.2 = 248 \text{ R.P.M.}$$

The theoretical horse-power required to move the air which is discharged through each square foot of effective outlet area under different pressures is given in Table II. This table, however, does not take into account the friction of the fan, so that, in practice, the result must be divided by the efficiency, which may be taken as 0.40 under average conditions.

TABLE II. RELATION BETWEEN PRESSURE AND HORSE-POWER IN CENTRIFUGAL FANS.

Pressure in ounces per square inch.	Horse-power per square foot of Effective Opening.
¼	0.175
⅜	0.324
½	0.498
⅝	0.695
¾	0.914
⅞	1.15
1	1.40

Example: A fan 4 feet in diameter has an effective outlet area of 4 square feet; hence, the power required when discharging into free air under a pressure of ¼ ounce is

$$\frac{4 \times 0.175}{0.40} = 1.75 \text{ horse-power.}$$

Resistance of Centrifugal Fans.

The Tables in the Supplement for speed, horse-power, and capacity of centrifugal fans have been computed by the methods given above, and apply only to fans discharging into free air. When connected with a series of ventilating ducts the effect is the same as partially closing the fan outlet, and thus reducing the volume and horse-power in practically the same proportion. In the case of schools, churches, etc., where shallow heaters are used, and the flue velocities do not exceed 800 to 1,000 feet per minute, the volume and horse-power as found in the tables for any given speed should be reduced about 20 per cent. In shops and factories where deep heaters are used and flue velocities run up to 1,800 to 2,000 feet per minute, there should be a reduction of about 40 per cent.

Disk Fans.

The following data are based on the assumption that the disk fans are connected with shallow heaters or with ventilat-

ing ducts of medium length, through which the air is flowing at a velocity of 800 to 1,000 feet per minute. The tables found in manufacturers' catalogues are usually for fans running in free air without the use of connecting ducts, hence the results are much in excess of those given by the following rules, which are for the average conditions commonly found in ventilating work.

TABLE III. SPEED, HORSE-POWER AND CAPACITY OF DISK FANS.

	Diameter of Fan in inches.								
	12	18	24	30	36	42	48	60	72
R. P. M.	1,300	900	600	500	400	350	300	250	200
H. P.	0.13	0.30	0.48	0.78	1.0	1.5	1.9	3.1	4.3
cu. ft.	650	1,530	2,400	3,900	5,200	7,350	9,600	15,500	21,600
R. P. M.	1,400	950	650	550	450	400	350	300	250
H. P.	0.14	0.32	0.52	0.86	1.2	1.7	2.2	3.7	5.4
cu. ft.	700	1,620	2,600	4,290	5,850	8,400	11,200	18,600	27,000
R. P. M.	1,500	1,000	700	600	500	450	400	350	300
H. P.	0.19	0.42	0.70	1.2	1.6	2.4	3.2	5.4	8.1
cu. ft.	750	1,700	2,800	4,680	6,500	9,450	12,800	21,700	32,400
R. P. M.	1,600	1,100	800	650	550	500	450	400	350
H. P.	0.24	0.56	0.96	1.5	2.1	3.2	4.3	7.4	11.3
cu. ft.	800	1,870	3,200	5,070	7,150	10,500	14,400	24,800	37,800
R. P. M.	1,700	1,200	900	700	600	550	500	450	400
H. P.	0.30	0.71	1.3	1.9	2.7	4.0	5.6	10.3	13.2
cu. ft	850	2,040	3,600	5,460	7,800	11,550	16,000	27,900	43,200
R. P. M.	1,800	1,300	1,000	800	700	600	550	.....	.....
H. P.	0.36	0.88	1.6	2.5	3.6	5.0	7.0	.....	.....
cu. ft.	900	2,210	4,000	6,240	9,100	12,600	17,600	.....	.....

In computing the volume of air moved, it may be assumed that each revolution of the fan moves the air in a direction parallel with the shaft a distance equal to 0.6 of the diameter, over its entire area, or

$C = 0.6\,D \times R \times A$; in which

C = cubic feet of air moved per minute;
D = diameter of fan in feet;
R = revolutions per minute;
A = area of fan in square feet.

The horse-power depends upon the velocity of the air through the fan and the resistance of the ducts. Under average conditions this may be taken as follows:

Velocity through Fan in Feet per minute.	Horse-power Required per 1000 Cubic Feet of Air Moved
800	0.20
1,000	0.30
1,200	0.40

A disk fan operates most economically when the speed is such that the velocity of the air-flow through it is from 800 to 1,200 feet per minute, and Table III is computed upon that basis.

TABLE IV. DEPTH, FINAL TEMPERATURE AND EFFICIENCY OF PIPE HEATERS.

Temperature of entering air, zero.
Velocity of air between the pipes, 800 feet per minute.

Rows of Pipe Deep.	Temperature to which the Air will be raised from Zero.			Efficiency of Heating Surface in B. T. U. per square foot per hour.		
	Steam Pressure in Heater.					
	5 lbs.	20 lbs.	60 lbs.	5 lbs.	20 lbs.	60 lbs.
4	30°	35°	45°	1600	1800	2000
6	50	55	65	1600	1800	2000
8	65	70	85	1500	1650	1850
10	80	90	105	1500	1650	1850
12	95	105	125	1500	1650	1850
14	105	120	140	1400	1500	1700
16	120	130	150	1400	1500	1700
18	130	140	160	1300	1400	1600
20	140	150	170	1300	1400	1600

Heaters for Hot-blast and Ventilation.

The efficiency of a heater is the number of heat units given off per square foot of surface per hour to the air passing over it. This increases with the difference in temperature between the steam and air, and also with the velocity of air flow. The final temperature depends upon the depth of the heater, and increases with the number of rows of pipe, and with the difference in temperature between the steam and air. Increasing the velocity of air flow, reduces the final temperature. Table IV gives the depth, final temperature, and efficiency for pipe heaters under different conditions. In this table it is assumed that the air enters the heater at a temperature of zero, and passes between the pipes at a velocity of 800 feet per minute. The free area through a pipe heater is approximately 0.4 of the gross or over all area.

Efficiency of Cast-iron Heaters.

The efficiency of a pin radiator 8 to 10 inches in depth may be taken as 1,500 heat units per square foot of surface per hour. Deep cast-iron heaters, made up of several rows of sections, may be treated the same as a pipe heater of the same depth.

The heating surface required may be found by the formula

$$S = \frac{T \times C}{55 \times E}, \text{ in which}$$

S = square feet of surface in heater;
T = temperature to which the air is raised from zero, or the number of degrees through which it is raised from any other temperature;
C = cubic feet or air to be heated per hour;
E = efficiency of heater.

Factory Heating.

The heating surface for factory heating is commonly expressed in lineal feet of 1-inch pipe. With all of the air used taken from out-of-doors, allow approximately 100 cubic feet of space for each foot of pipe for exhaust steam, and 150 cubic feet for steam at 80 pounds pressure. If air from the building is rotated through the heater, substitute 140 and 200 for the above figures.

Air Velocities.

The average air velocities given in Table V may be used in the different parts of a heating and ventilating system.

TABLE V. AIR VELOCITIES FOR DIFFERENT PARTS OF HEATING AND VENTILATING SYSTEMS.

Section of System.	Velocity in Feet per minute.
Through inlet windows	800 to 1,000
Between inlet and heater	800 to 1,000
Through heater	800 to 1,000
Schools and churches—	
Main ducts	1,000 to 1,200
Branches, large	800 to 1,000
Branches, small	700 to 800
Uptakes	600 to 700
Shops and factories—	
Main ducts	1,800 to 2,000
Branches	1,500 to 1,800
Uptakes	1,200 to 1,500

Volume of Air Required.

The volume of air supplied to a building is usually based on the number of occupants. Table VI represents good modern practice and may be used with satisfactory results.

TABLE VI.

Air Supply per Occupant.	Cubic Feet per Hour.
Hospitals	4,000 to 6,000
High schools	3,000
Grammar schools	2,400
Theatres and halls	1,500
Churches	1,200

* * *

In the engineering review of the May issue of MACHINERY it was mentioned that the White Star line planned the building of steamships a thousand feet in length. This statement, however, has been corrected, and it is now reported that the new steamships are to be 840 feet long, which is about 50 feet more than the length of the *Mauretania*, hitherto the longest vessel built.

MAKING CROSS-HEAD PINS FROM BAR STOCK IN THE GISHOLT TURRET LATHE.

The requirements of the railroad shop are so different from those of factories engaged in repetition work, that it is not always possible to use in them the highly developed machines that have been devised to meet modern manufacturing requirements. It is seldom that parts have to be made in large quantities, and the work is, in general, heavier than is usually adapted to elaborate methods of machining.

Despite these general conditions, however, the Gisholt Machine Co., Madison, Wis., some time ago decided that there was a field in the railroad repair shop for the particular turret lathe of which they are the builders. Without requiring any further development in the design of the machine or the tools used with it, it was already well adapted to the machining of such work as bushings, brasses, pistons, cylinder heads, bull-rings, eccentrics and other small and medium-sized cast parts used in the locomotive. But there is not always, in the repair shop of ordinary size, enough of even this wide range of work to keep a machine busy all the time; so it became necessary, in developing the lathe to its maximum of usefulness, to design tools and methods of working for producing miscellaneous turned steel parts, such as the cross-head, valve motion and brake hanger pins, etc., which were previously made from forgings. The accompanying illustrations and description show the successful way in which this machine, primarily designed for chucking, has been adapted to the finishing of such parts from the bar.

The machine used is of the type called by its builders the "Big Bore" lathe, which is simply the standard machine with an extra large spindle for bar stock, the principal features of special interest in connection with this work being in the tools used rather than in the machine.

In Fig. 1 the machine is shown rigged up for turning a cross-head pin, shown completed in the chuck and ready to be severed from the bar. As is more plainly indicated in the diagram, Fig. 2, which gives the lay-out of operations, this cross-head pin is of the usual type, having a central cylindrical body F which is the journal for the connecting-rod brasses, and two tapered diameters E and G by means of which it is fitted into the sides of the cross-head, being held in place by a nut threaded onto the stem H. It will be noted that all the various portions of the work are lettered, and in following the different operations, the cutting blades in each tool will be lettered to correspond with the parts of the work which they machine, thus making it easy to follow the course of the work.

The stock A is held in a scroll chuck by three hardened jaws B and is further steadied and clamped by the supplementary chucking screws C, threaded into blocks clamped to the face of the chuck alternately with the jaws. The stock being fed to length, as will be described later, the end of the bar is faced with tool N in the cross-slide turret. The first turning operation is performed by box tool No. 1 in the main turret. This tool rough turns all the various diameters and shoulders of the work, the various blades E_1, F_1, G_1, etc., turning the corresponding portions E, F, G, etc., of the work. Two sets of back rests L are provided, the forward one of which bears on shoulder E and the rear one on diameter H. The last tool K_1 finish faces the end K of the work.

The pieces being thus brought approximately to size, the main turret is revolved to bring box tool No. 2 into operation. In this, blades F_2, H_2, and K_2 turn to size shoulders F and J, and face K, the holder being steadied meanwhile by two sets of back rests L_2 bearing on shoulders F and H, as in the first cutting operation. Box tool No. 3, which is next presented to the work, carries taper shaving blades E_3 and G_3 for forming the two taper bearings on the work. These taper bearings fit into corresponding taper seats in the cross-head. The tool is back rested on the work as before while this operation is in progress. The positive stop R determines the length of this taper turning, by stopping against the face K. This arrangement insures duplicate work when cutters E_3 and G_3 are once properly set.

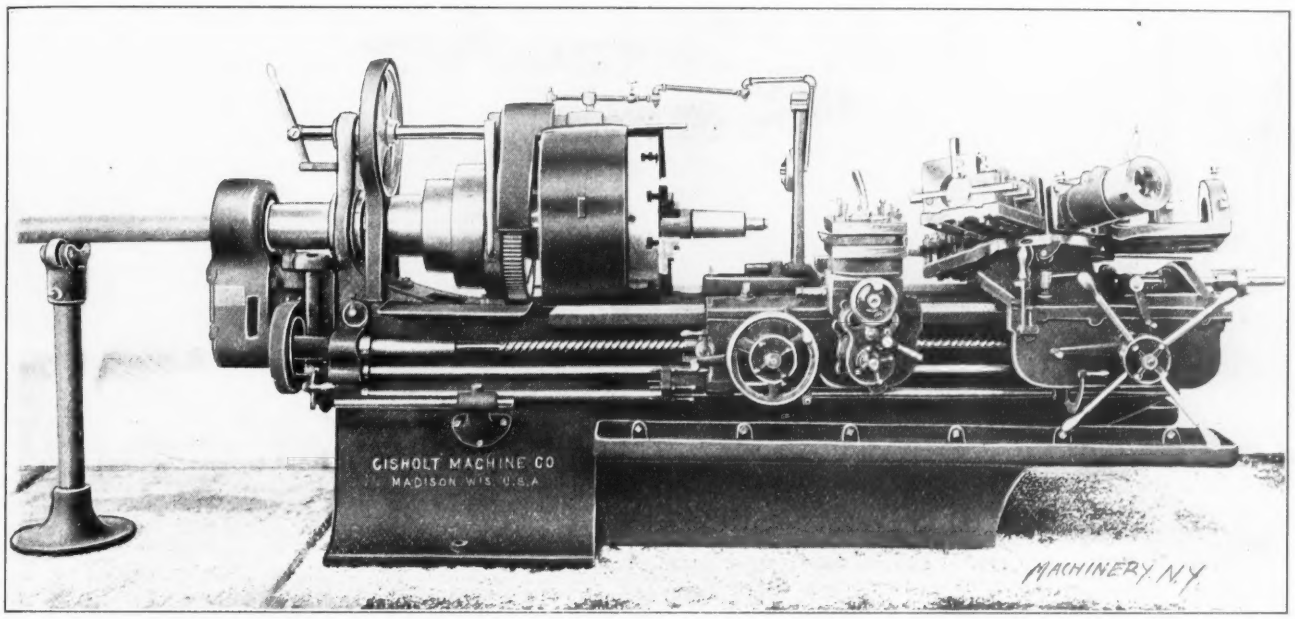


Fig. 1. Gisholt Turret Lathe arranged for Railway Shop Work; shown set up for Finishing Cross-head Pins.

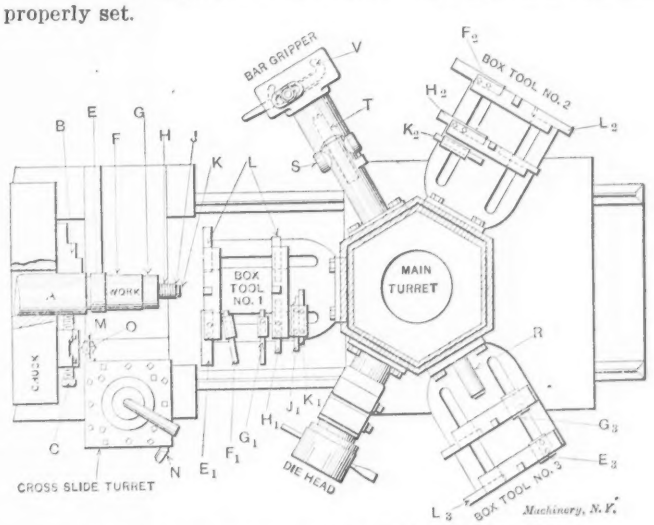


Fig. 2. Tool Equipment used for Making Cross-head Pins.

All the surfaces on the pin having been brought to size, the next operation consists in cutting the thread, which is done by the die-head shown. The part being thus completed, cutting-off tool M in the cross-slide tool-holder is used for severing the work from the bar. Owing to the large diameter of the stock, this slender cutting-off tool is supported by an adjustable threaded post O, more plainly seen in the foreground in Fig. 3.

After the piece has been cut off, jaws *B* and set-screws *C* are loosened to allow the work to be fed out. The feeding is done by the "bar gripper" shown mounted in the turret in Fig. 2. The bar is fed by being pulled through the chuck instead of being pushed from the rear, as commonly done. The procedure is as follows: By the operation of the rapid traversing device for the carriage, the bar gripper is brought rapidly to the piece. The self-acting jaws *V* then grip the stock firmly. The carriage is then returned by power until the bar is drawn out to approximately the proper length after which the gripper is released. The body of the gripper

Fig. 3. Box Tool and Cutting-off Blade; note Support for Blade.

is then swung upward out of the way about pivot *S*, and the turret slide is brought forward to a positive stop, arbor *T*, meanwhile, pushing the work along until it projects just the right amount, *T* being accurately adjusted for this purpose. The operations then proceed as before.

Figs. 3 and 4 give a good idea of the tool equipment used. Fig. 3 shows the cross-slide turret or tool-post and one of the box tools in position for operation. In Fig. 4 a front view of the box tool is shown. It will be seen that this outfit of tools is suited for work of a large range of diameters and lengths, although this adjustability is not obtained at the expense of quickness and simplicity in changing from one size

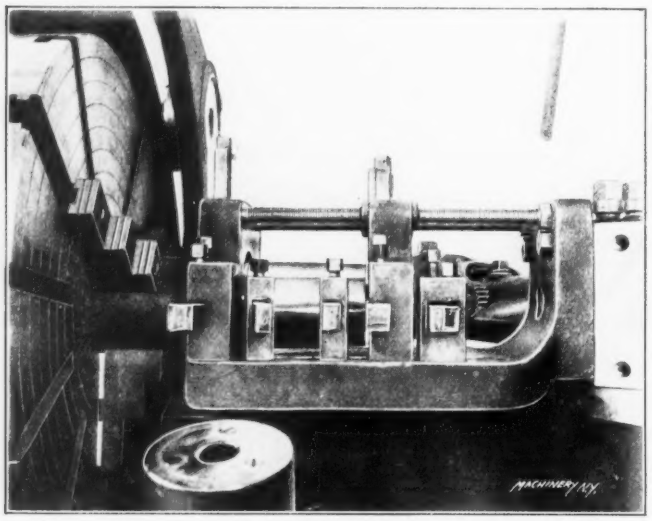


Fig. 4. Front View of Box Tool showing Adjustability of Blades and Back Rests.

to another. The holders for carrying blades and back rest jaws combined, are tied together and with the body of the cutter by threaded tie-rods, which stiffen the whole structure, allowing heavy cuts to be taken.

The makers state that the convenience of a tool outfit of this kind makes it possible with bar work, as with castings, to finish parts in lots of as few as six or eight of a kind, and still save a large amount of time in the operation. Owing to the fact that the work of this kind may be made from bar stock, the expense of forging the blanks from which these pins were formerly made is done away with. Besides this, owing to the manner in which the work is chucked, there is no time lost in centering as with the older methods. In some shops such parts as knuckle and cross-head pins are made for stock, finished complete except the taper surfaces, which are left large and finished to size and fitted in place as required.

* * *

A MASTERPIECE AMONG PERPETUAL MOTION ADVERTISEMENTS.

The following notice, here reprinted verbatim, appeared in a recent issue of a Hartford paper, sent us by one of our readers:

FOR SALE—A Wonderful Machine. A machine that will overcome Newton's third law and transfer a horseshoe magnet force into a revolution, and will produce more power than what is put into the machine. Because not having the funds to build a machine in a perfect way so I can demonstrate it in practical mechanical working order. It is a perfect success from the mechanical laws of nature which I have tested in their natural working order, and from the small machine which I have in perfect working order to demonstrate from that when the electro or the horseshoe magnet system is connected with the machine it will do the work. Just as I have stated, every professor on the face of the earth will have to give the same statement as I have in regard to this machine in the form it does its work, even in case it should not produce more power than what is put into the machine, it would be one of the most mysterious mechanical laws that the professor ever came across which they pronounce correct to-day, therefore it would be a valuable machine to put on exhibition to demonstrate to the world in a mechanical form that it is impossible to make a machine that will produce more power than what is put into the machine it would show then that it was imperative to get the perpetual motion system in a mechanical form. Therefore by putting this machine on exhibition if it should not work it would bring in a small fortune, more than the machine would cost to build, and by publishing a book of the six mechanical laws which I have worked out, what is the foundation of this machine to work from that would bring in a small fortune for itself; therefore it is impossible to lose one cent by investing in this machine. I have studied these laws out to their limits and according to the laws the machine can be made to drive small or big machinery. Now I would like to know if there is a lady or gentleman on the face of this earth who has funds enough that will be so generous and borrow me Five Thousand Dollars so I can build a machine and exhibit it before the public.

This man hopes to "catch 'em coming and going," evidently, for he promises that the investment will be a profitable one, even if his machine proves a failure. This is, we believe, a new wrinkle in perpetual motion promotion.

* * *

A clever wrinkle is used by the Stromberg Electric Mfg. Co., Chicago, Ill., in the construction of the Perry time stamp for securing rubber type bands to hexagonal brass printing wheels. The brass wheels are made from hexagonal stock in a screw machine, and are prepared for the rubber type bands by gripping them closely together on a mandrel and covering the edges with a thick coating of brown shellac. When thoroughly dried, the wheels are separated and the rubber type (which is vulcanized in bands), is slipped onto the periphery of the wheel, and then dipped into alcohol. The alcohol penetrates between the rubber and the wheel, softening the shellac and causing it to adhere to the rubber. Upon removal from the alcohol the shellac quickly dries, leaving the rubber firmly attached to the wheel. The reason for applying the shellac in this manner is to avoid getting it upon the face of the rubber and making the mussy job that would unavoidably result from direct application.

* * *

An engineering firm in Hamburg, Germany, contemplates, according to *Frankfurter Zeitung*, the erection of a power plant at the mouth of the river Elbe, the driving power of which it is proposed to derive from the tidal movement of the sea. It is expected that two neighboring cities of comparatively large size will be supplied with electric light, and that electricity may also be supplied for electric railways. The cost of the electric current is calculated to be extremely low. The statements made by the firm itself, however, are to be accepted with considerable reservation. In new departures of this kind the engineer requires to see results before his enthusiasm can be aroused in any remarkable degree.

LETTERS UPON PRACTICAL SUBJECTS.

ON SENDING ELECTROTYPES ABROAD.

Machinery agents and technical editors over here get a good many electrotypes which are in the condition of the dog that was sent by express and ate his tag. The "stickers" of the post-office, custom house and forwarding agents usually cover the sender's name. Blocks should be marked with the sender's name on the edge, not on the bottom. As "samples without value," they come more cheaply and quickly, and make less bother at both ends of the line, than as postal packages. A card of advise should be mailed the same time as the blocks.

Dresden, Germany. ROBERT GRIMSHAW.

QUICK RUSTING OUT OF SMOKESTACK.

We had a steel smokestack 80 feet high, 42 inches diameter, made of No. 8 steel. This stack, after being in continuous use for only three years, was completely eaten up by rust, and had to be taken down. Some of the sheets were so wasted away as to be thin as paper. We would like to know if any of your readers have had a similar experience. What is the cause of it and how can it be prevented? The fuel used was run-of-mine, Kanawha gas coal such as is used in the Cincinnati district, and the analysis is as follows: Moisture, 0.39 per cent; volatile matter, 38.47 per cent; fixed carbon, 58.01 per cent; ash, 3.13 per cent; sulphur, 0.666 per cent. We are at a loss to understand why the stack should have gone to pieces so quickly. Is the kind of steel used in smoke stacks more readily attacked by rust than ordinary grades of steel used in other constructions? THE J. & H. CLASGENS CO.

New Richmond, Ohio.

AN EXAMPLE OF HIGH-SPEED DRILLING.

The accompanying table gives the results of some trials made with our heavy upright drilling machine, illustrated in the March issue of MACHINERY, using a special brand of twist drills. The trials were made to obtain the maximum capacity

HIGH SPEED DRILLING TESTS ON DROOP & REIN DRILLING MACHINE.

Diam. of Twist Drill	Feed per Revolution.	Number of Revolutions	Depth of Holes.	Time.	Effective Feed per min.	Calculated Feed per min.
				min. sec.		
2	10/1000	145	2 7/8	2 24	1 3/8	1 7/16
2	15/1000	145	2 7/8	1 35	2 1/8	2 3/16
2	18/1000	150	2 7/8	1 15	2 5/8	2 11/16
2	18/1000	150	3 3/4	1 35	2 11/16	2 3/4
2	25/1000	160	5	1 25	3 7/8	3 15/16
2	35/1000	140	3 3/4	0 56	4 1/2	4 13/16
2 3/8	18/1000	120	3	1 45	2 1/16	2 3/16
2 3/8	18/1000	130	3 1/16	1 40	2 3/16	2 3/8
2 3/8	18/1000	130	3 9/16	1 48	2 5/16	2 3/8
2 3/8	25/1000	120	3	1 15	2 7/8	2 59/64

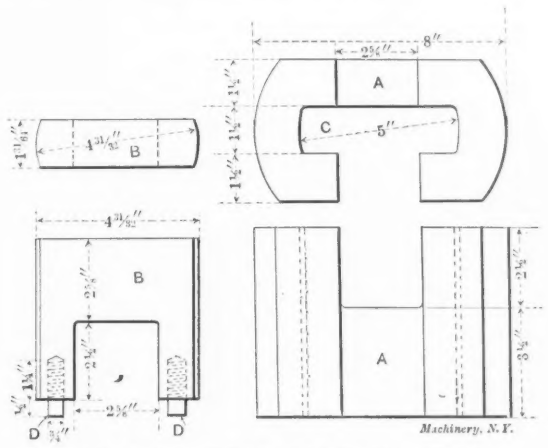
of the drills. The holes were drilled from solid steel of about 55 kilos resistance per square millimeter. Perhaps the table will be of interest to some of your readers. DROOP & REIN.

Bielefeld, Germany.

[The designation "55 kilos resistance per square millimeter" refers to the tensile strength, and gives a comparison for the hardness of the steel. In this case the material had a tensile strength, in English units, of 78,000 pounds per square inch. Inasmuch as the hardness curve of untempered carbon steel is approximately parallel to the curve of tensile strength, it follows that a statement of the tensile strength gives a fair idea of the hardness of the material.—EDITOR.]

CUT-OFF TOOL FOR THE STEAM HAMMER.

A cut-off tool to be used under a steam hammer is shown in the illustration. It is made of tool steel, and can be either forged and used with very little finish, or be made accurately by finishing all over. The one in use at the shops was made rough, and gave very good results, cutting off bar iron as fast as it could be placed in position under the hammer, and only requiring two men to operate, as against three with the old way. The tool shown is intended for cutting either flat or square stock. The rest upon which the steel is placed is shown at *A*. After the bar has been placed upon the rest, the cutter *B* is placed in the slot *C* in the rest *A*, and the hammer brought down. Better results can be obtained by using different cutters for the various sizes of stock. The studs *D* are used to center a pair of springs, which bring the cutter back into position, after a piece has been cut off, ready for another blow. The upper part of the cutter is made 2⅝



A Tool for Cutting off Stock under the Steam Hammer.

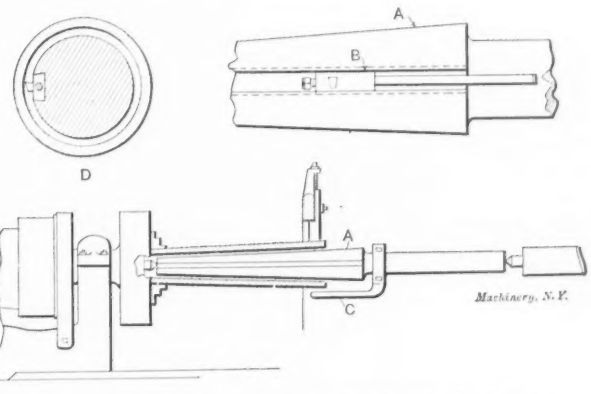
inches, or ⅛ inch longer than the depth of the slot in the rest, so that the piece is cut off before the top of the cutter is flush with the top of the rest.

When it is desired to cut off round bar steel, the same style rest can be used with the exception that instead of the slot a round hole is drilled which is ⅛ inch larger than the bar, and the cutter *B* must have a half circle cutting edge, instead of a flat edge as shown. Very stout springs should be used under the cutter. It is not necessary to have the cutter very hard, as it is liable to crack. For angle irons the same principle can be applied, only the tool must be made stronger in proportion to the size of the stock.

Jackson, Tenn. JOHN BRANDLE.

TOOL FOR TURNING HARD BRONZE CASTINGS.

The specifications for the sleeve bushings which form bearings for the axles of a certain make of gun carriage, call for phosphor bronze as hard as steel can cut. It will be seen that something besides an ordinary boring-bar is required to



A Boring Tool Designed to give Great Rigidity to the Cutter.

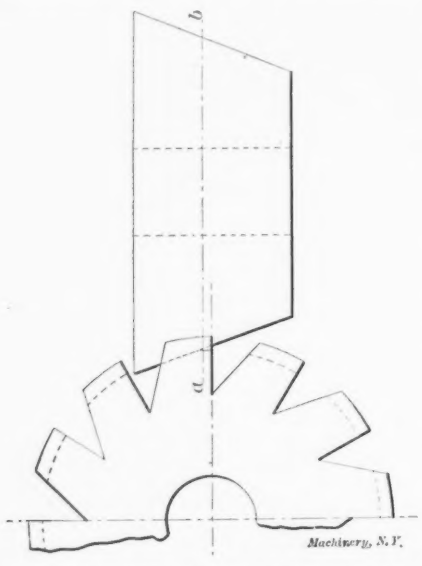
bore these castings, and the bar shown in the engraving is used for this purpose. It consists of a heavy steel bar *A*, turned taper about half its length, the tapered portion being small enough to enter the rough casting without touching any part. The shank portion is smaller than the head of the taper, and a dove-tailed slot is planed parallel with the taper, so that a closely-fitting block carrying a tool, as shown at *B* in the detail, gives a very short and rigid hold for the tool. The block is attached to a rod *C* which is in turn fastened to the tool-post on the carriage, by which means the tool is fed to its work. The bar *A* is held on the centers, and is kept

from revolving by a suitable clamp or dog, one form of which is shown at *C*, this being wedged in the lower part of the steady-rest. At *D* is shown a section of the bar and sleeve. The sleeve is turned outside before being bored, and after boring with the tool described, it is reamed.

Ottawa, Ont., Canada. W. L. McLAREN.

SELECTING CUTTER FOR CONCAVE MILL.

"M. E. M." offers in the How and Why section of the March issue of MACHINERY a rather complicated problem in mathematics. As stated by the editor, an exact solution is impossible. Maybe, however, a formula could be worked out that would give the same width of land at three points, *viz.*, the bottom of the segment and the two points on the largest diameter of the cutter blank. It is doubtful, however, if anybody would want to use it, if he had it, as no less than six variables would have to be taken care of, namely, the arc of the circle wanted, its radius, the radius of the cutter blank, the angle included between two teeth, the width of land, and the edge angle of the milling cutter. This rather looks like "more than the job is worth." I can offer no approximation that will fit the case as presented. But if "M. E. M." will go about it a little differently, there is a very simple solution, giving results well within the limit called for on that class of work.



Method of Milling a Concave Mill so that the Width of the Land at the Center and Outside Edges will be Approximately Equal.

First, gash the cutter blank, and then set it with a cutting edge vertical. Then select an angular cutter for the relieving operation of such size that at some plane, as *a b* in the sketch, it will be of the same diameter as the circle on the edge of the blank, and sink it into the blank to this line. In this way a semi-circle can be relieved to a sharp edge with theoretical accuracy. If the land is very wide, there would be an error, most of which could be compensated by a slight rotation of the blank, but this would seldom be necessary, as the land would not generally be over 1/16 inch to 3/32 inch wide, and for all such cases the method is near enough.

Washington, D. C. H. K. HARRING.

THE EFFECT OF DISTILLED WATER ON LIFE OF MILLING CUTTERS.

One of the English technical papers incorrectly reported my remark on lubrication on the discussion of Dr. Ashton's paper. [See note on page 454, engineering edition, March issue.] What I really said was that a manager of a motor car works mentioned to a friend of mine that he had increased the life of his milling cutters from two to ten times their original life by using distilled water in making his suds instead of ordinary untreated water. As I had no data to substantiate the statement, I gave it for what it was worth.

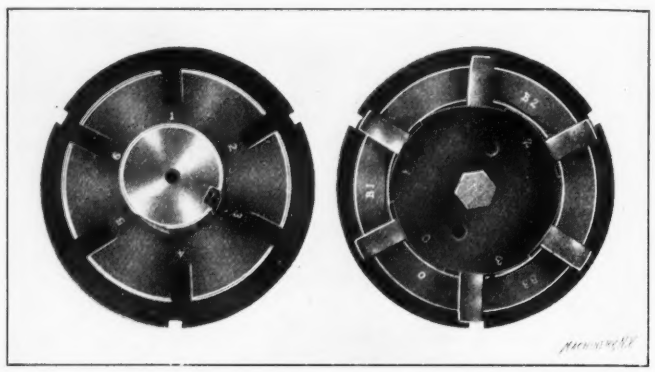
Personally, I am a little incredulous that an improvement to the extent mentioned is possible, yet I am convinced that better results can be gotten by using distilled instead of ordinary water in a lubricant.

The theory upon which I base this statement is that with distilled water the objectionable earthy carbonates and sulphates are removed, and do not, therefore, have a deleterious effect upon the cutting edge of the milling cutter. Also, the magnesium chloride in "hard" water has a slightly corroding action on the tool. The above elements in combination with a lubricant would certainly dull the edge of a tool and consequently reduce its life. The water at the works referred to was particularly "hard." F. CARNEGIE.

Enfield Lock, England.

LARGE ADJUSTABLE TAP.

The accompanying half-tones illustrate a rather unusual way of constructing an adjustable tap. The tap shown is used for tapping out a large cap, and the diameter of the thread in this cap must be full size all the way to the bottom of the hole. The principle of adjustment in this tap permits it to retain its full diameter on the front end of the inserted chasers. Figs. 2 and 3 show the general construction of the tap. The threaded chasers are held in place by shoes, shown



Figs. 1 and 2. End Views of the Adjustable Tap.

in detail in Fig. 3. These shoes are tightened by the small slotted head screws shown. It will be noticed that there is a shoe between every other pair of blades only, and that the metal of the tap body is left solid between alternate pairs, so that when the blades are tightened in place by means of the shoes, they are held firmly up against the body part of the tap. The means by which the adjustment is accomplished is best shown by the end view in Fig. 2. It will there be seen that the bottom surface of the ends of the chasers rest against the outside edges of a disk or cam, milled with steps so that on being turned, all the blades will move outward an equal amount in a radial direction. This cam is shown in detail in Fig. 3. It is provided with two holes, as shown in

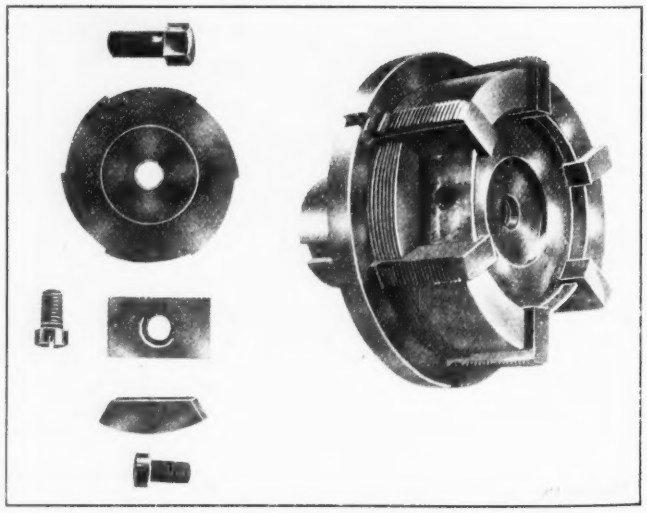


Fig. 3. View showing the Construction of the Tap.

Fig. 2, for a spanner wrench. The chasers can be moved forward in a longitudinal direction, by adjusting the collar shown in Fig. 3, at the upper end of the tap body.

Fig. 1 shows a view of the tap from the shank end. Marks (not shown) on the back of the shank indicate, first, the size of the tap, which is 4.520 inches, then the drawing number, and, finally, the number of the bin in the tool-room where this tap is kept when not in use. The upper ends of the chasers or blades simply bear against the face of the threaded collar.

When having adjusted the tap, it is evident that the front end of the chasers will have all the cutting to do, and for this reason it is likely that many will criticise the construction.

However, this tap was made nearly four years ago, and has given satisfactory service for the purposes for which it was intended, and this is, of course, the main consideration.

Decatur, Ill. ETHAN VIALL.

REASONS WHY SO LITTLE IS HEARD FROM FORGE SHOPS.

In the January issue of MACHINERY the editor remarks that it is strange that there is so little literature on drop forging and machine blacksmithing, considering the importance of the art. It would not seem so strange were the conditions under which the men actively employed at such work were better known. Manufacturers are principally responsible for existing conditions. Quite often we find a thoroughly up-to-date manufacturing plant with the forge shop in the most obscure corner, practically the place the farmer would use for a hog-pen; and the blacksmith is looked upon as a disagreeable necessity or an expensive luxury. Very little has been done to make the art of blacksmithing attractive to the young American, with the result that we depend almost entirely upon the imported article to do our iron and steel working.

Usually the inside of the forge shop compares well with its location: a great and fearful combination of scrap, discarded tools, and smoke, slightly mixed with modern machinery such as an occasional steam- or trip-hammer, usually of a design out of proportion with the work for which it is intended. System is conspicuous by its absence, and as a rule men employed in such shops have adapted themselves to their surroundings. The writer has been employed in shops of from four to ten forges, with scarcely enough tools to equip one fire. The result is that the "borrow-and-lend" or "first-come-best-served" principle had to be adopted. Much time was lost in hunting up tools, and quite often when they were located, some one else was using them.

Too much seems to be taken for granted both by the management and by the blacksmith himself. The manufacturer seems to take for granted that the equipment of our grandfathers is good enough for the blacksmith of the present day; and it takes a great deal of argument to convince him that a fixture for a steam hammer, a set of dies, a former, or a modern furnace, would reduce the cost of production. The same man, however, is willing to get any kind of machine or appliance to keep his machine shop or tool-room up to date. On the other hand, a great many blacksmiths take it for granted that because some one who had a reputation made a piece of work in a certain way, there is only that one way of doing it. They do not seem to trouble about thinking for themselves, and will find all kinds of objections to up-to-date appliances: A furnace will heat too many pieces at one time, the noise deafens them, the trip-hammer sounds like a boiler-shop, and so forth; but they never mention the increase of production or reduced cost. And, too often, when they find a thinker who gets ahead of them, they will brand him the fellow who is trying to get a mortgage on his job.

It is very rare that we find a well-educated man in the forge shop. The majority of American blacksmiths are recruited from boys who have had to earn a living at the first thing which would bring in the most money—usually doing odd jobs around the forge shop, or operating a steam hammer, as a start. After a time they may be put to help a blacksmith, and if they are bright and have a foreman who recognizes merit, they may get a forge, doing small work. Once at the forge, they are usually there for life. There are very few who are blacksmiths from choice, and so few of them have a fair education, that it is not surprising that so little has been written on the art of blacksmithing.

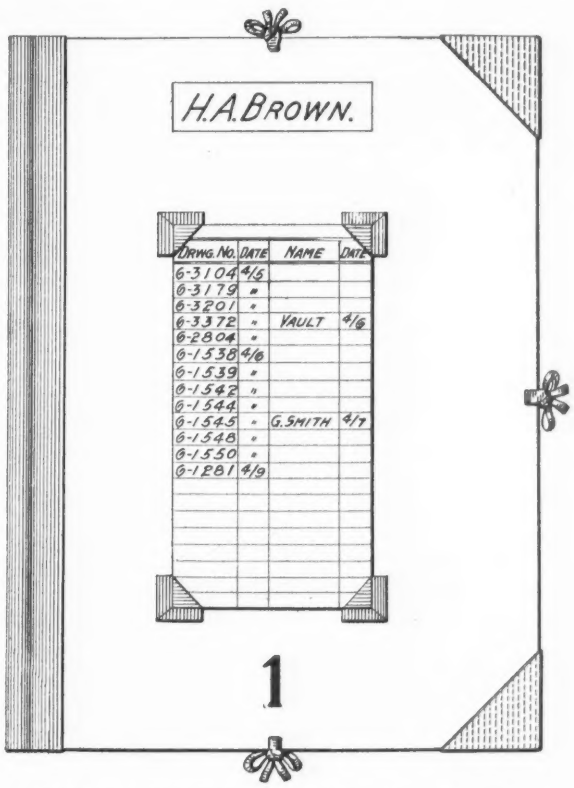
If manufacturers would do something to bring the forge shop up to the standard of the average machine shop in the way of equipment, ventilating, heating, provision for wash-rooms, etc., and besides take an interest in the boys who are learning the trade, encourage them to study mechanical drawing, arithmetic and such things as would help them to do work according to mechanical principles, we would in a short time have our forge shops filled with men who would bring the art of blacksmithing to the front. But few people seem to realize the importance of blacksmithing, although there is not a machine-building concern, nor an individual, who does not depend upon it more or less. What would happen to our industries if it was not for the men who earn their living behind the anvil?

JAMES CRAN.

Plainfield, N. J.

DRAFTSMAN'S PORTFOLIO.

Difficulty is often experienced, and time is wasted, in "hunting up" tracings. Every large firm has a boy or two to take care of the tracings in the files or the vault, and who are required to see that every drawing is properly charged to the draftsman requesting to borrow it. It is a fact, however, that tracings often disappear among the piles the draftsmen have on their tables. If, for instance, a certain tracing is wanted by the superintendent, the way to get it is usually as follows: After looking up the number, the boy in charge of the vault finds out that the drawing in question was charged to Brown on a certain date. He goes to Brown, looks through the tracings, and after a while, to make sure that the one he wants is not there, upon asking for it, he gets the following answer, "Somebody took it," and the boy is just as wise as before. He will have to look through all the piles of tracings, the number of which may reach to hundreds.



A Draftsman's Portfolio in which the Tracings in Use are kept.

If the boy has good luck, he will find what he is looking for, but he as likely may have to report that the tracing cannot be found, which, of course, will not satisfy the superintendent. This is an every-day occurrence, but the following device or system will do away with this trouble:

Let every draftsman have a portfolio large enough to hold the largest standard size of tracings. This portfolio should be of heavy cardboard, with the back and corners leather-covered. The front should have a number corresponding to the number of the table where it is used. The portfolios being kept in the vault over night, will assure quick distribution when they are taken out of the vault in the morning. A small block of loose leaves divided into four columns should also be attached to the front. The first column is to be used for the drawing number, the second and fourth for dates, and the third for the name of the draftsman to whom the tracing has been given. The portfolio should also have three or more partitions of cardboard to separate the drawings of different sizes or types of machines, thus facilitating the finding of any particular tracing. The drawings should be handled in the following manner: Each person taking a tracing out of the

vault, should register his name and the date on a card for that purpose, to be left in place of the tracing. After returning to his own table, the draftsman should at once put the number and the date in their proper columns. Now, if Smith asks for the same tracing later on, his name and the date should be put down by him in the proper column. When the boy looks for a tracing, all he has to do is to glance at the cover to know at once whether the tracing is in the portfolio or has been given to Smith. In this way he will find the tracing very quickly. If the tracing is returned to the vault or to Brown, the corresponding charge should be cancelled. By this method, the tracings will be kept clean and in good shape. GEO. WILLIAM BOHLER.

Milwaukee, Wis.

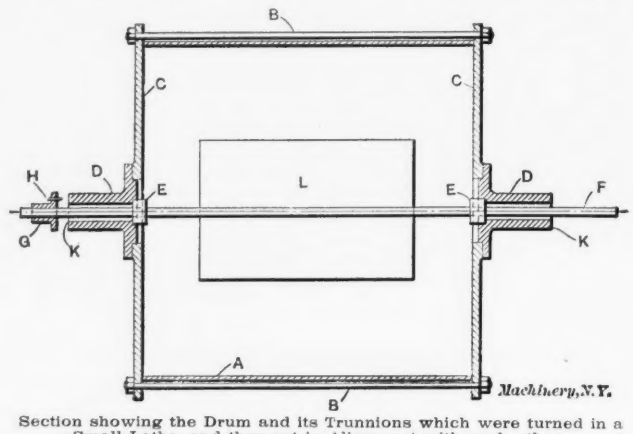
[While the system proposed by our correspondent has many good features, it is likely that the draftsmen would find it troublesome to open up the big portfolio every time they wanted to get or put back a tracing, and after a while it is to be feared that most of the tracings would be found on top of the portfolio, and not inside. That, however, may be a minor matter. A more important point to call attention to in this connection is that *tracings should not be used for reference*. Tracings are made to take blue-prints from, and for no other purpose. The only thing given to the draftsman for reference should be a blue-print; then there is no danger of soiling or spoiling the tracings by constant handling, nor of losing them; and a blue-print is fully as satisfactory as a tracing for reference.—EDITOR.]

FITTING TRUNNIONS TO A LARGE DRUM.

The sectional view shown herewith represents a steel drum held between two cast iron heads by rods with nuts on each end. To each head is bolted a flanged, hollow cast iron trunnion on which the drum is to revolve. In a shop where there is no lathe large enough to swing the drum, the problem is how to get the trunnions turned and bolted on so that they will be in line and true with each other.

Referring to the illustration, *A* is the steel drum, *B*, the rods for holding the drum and heads in place, *C*, the cast iron heads, *D*, the trunnions, *E*, two cast iron collars, *F*, a piece of cold rolled shafting, *G*, a flanged sleeve with a brass thumb-screw to hold it at any desired place along the shaft, *H*, a piece of drill rod sharpened for a scriber and held in the flange of the sleeve *G* by a small set-screw. After removing all rough spots on the bosses against which the trunnions *D* are to be bolted, holes are drilled through the heads *C* for the bolts which are to hold the trunnions. The steel drum is then placed between the heads and fastened by the rods *B* which pass through holes cast in the heads. The drum is now ready for putting the trunnions on. The trunnions are taken to the lathe and caught in the chuck by the flange, and the ends *K* faced. Then catching the end *K* in the chuck, the cored hole which passes through the center of the trunnion is counterbored a short distance at the flange end to fit the outside of the collars *E*, these collars having previously been bored a close running fit for the shaft *F*, and turned true on the outside. After chamfering the corner of the counterbore, the trunnion may be steadied by means of a pipe center while the outside diameter of the flange is turned true with the counterbore. The flange is then faced and fitted to the smallest diameter of the opening in the drum head, assuming that the opening will be somewhat out of round. The trunnions are now put in their places on the drum heads, and fastened by means of a strap across the opening in the head, and a bolt long enough to reach through the center of the trunnion and a washer against end *K*. By reaching in at the opening *L* in the drum, the bolt holes are marked on the trunnion flanges. After marking the trunnion flanges and drum heads so that each trunnion can be put back in the same place and position, the trunnions are removed and the bolt holes drilled after which the trunnions are put back in their places on the drum heads and all the bolts put in and tightened. Ordinarily on a rough job of this kind the flange seats on the drum heads will be true enough so that the trunnion flanges under the pressure of the bolts will come down tight all round, if not, the seat must be chipped or planed to give a fair bearing.

Now, with the trunnions on the drum heads, and bolts all tight, the cold rolled shaft is put in place as shown in the drawing with the two collars *E* in the counterbores of the trunnions. It is evident that the shaft is true with the outside diameter of the flanges at both ends of the drum. After coating the ends *K* with any good marking material, the sleeve *G* is placed on the outer end of the shaft and moved along until the scriber *H* is very close to the end *K* of the trunnion, where it is made fast by means of the brass thumb-screw, not shown. The shaft is now revolved, by taking hold of the sleeve *G*, and at the same time pushed gently until the scriber comes in contact with the end of the trunnion and scribes a circle thereon. It is obvious that the circle so scribed is true with the shaft bearings in the collars *E*, and also true with the outside diameter of the trunnion flanges. The sleeve is now removed, and placed on the other end of the shaft and the other trunnion scribed in the same manner. The trunnions are now removed and taken to the lathe, and



Section showing the Drum and its Trunnions which were turned in a Small Lathe, and then set in Alignment with each other.

caught by the flange end in the chuck and set so that the outside diameter of the flange and the circle on the end *K* both run true at the same time. The cored hole which passes through the center of the trunnion may now be bored a short distance in at the end *K*, and chamfered to fit a pipe center which may be used to steady the work while roughing, after which the center should be withdrawn to see if the circle is still running true; if not, it must be made to run true with the outside diameter of the flange after which the finishing cut is taken. After finishing to size, the trunnions are put in their places on the drum heads, and bolted up in the exact positions which they were in when the circles were scribed on their ends at *K*, and they will be in line and true with each other as desired. J. T. GRIMSHAW.

Detroit, Mich.

AN ALTERNATIVE PLANER TYPE SUGGESTED.

We have read with much interest your description of the huge Bement (Niles-Bement-Pond Co.) planer, published in your January issue. It seems to us that if we take into account the depreciation, interest on money invested, the large space taken up by the machine and the extra power required, a sum of at least 50,000 to 60,000 francs per annum should be charged against it. The first cost, no doubt, was not far from 300,000 francs. It is a pity that we do not know exactly the kind of work this machine has to plane, but it seems that a planer built on the style shown in the accompanying half-tone illustrations, would have served general purposes much more economically and would have been fully as adaptable, especially so if the bottom table could be raised and lowered by hydraulic pistons so as to place the work at the required height.

M. Morane, of Paris, has a planer of this type in a much smaller size with the hydraulic system to adjust the table, and it is giving excellent satisfaction. In our opinion a planer built according to this plan would not require more than 25 horse-power, and it would take up no more room than the machine illustrated in your January issue. There certainly would be much difference in the capital invested.

SOCIETE ANONYME DES MOTEURS A GAZ A. BOLLINCKX.

Huyssinghen, Belgium.

[The type of planer referred to in the above is that built

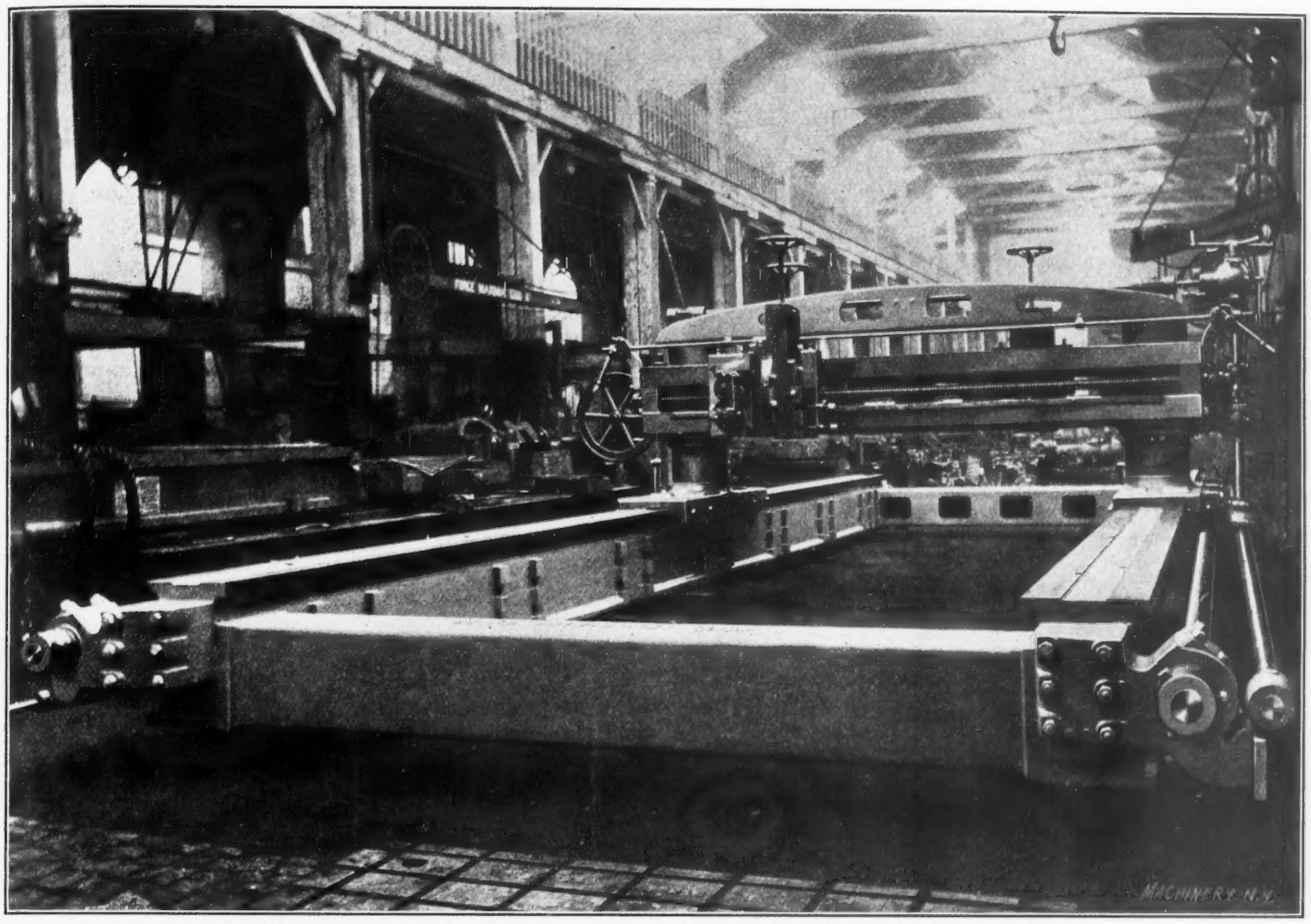


Fig. 1. Pit Planer built by Societe Anonyme des Etablissements Fetu-Defize, Liege, Belgium.

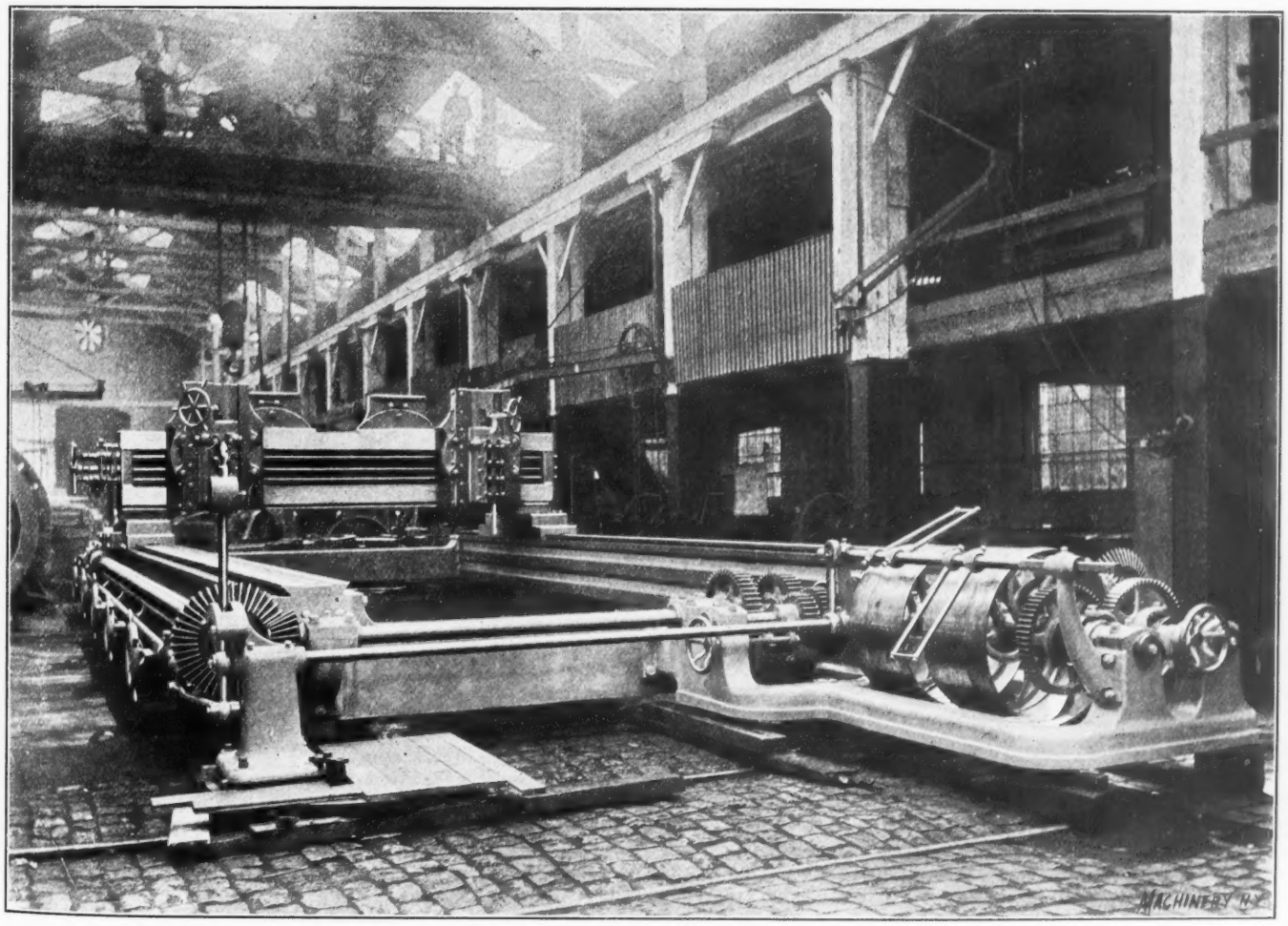
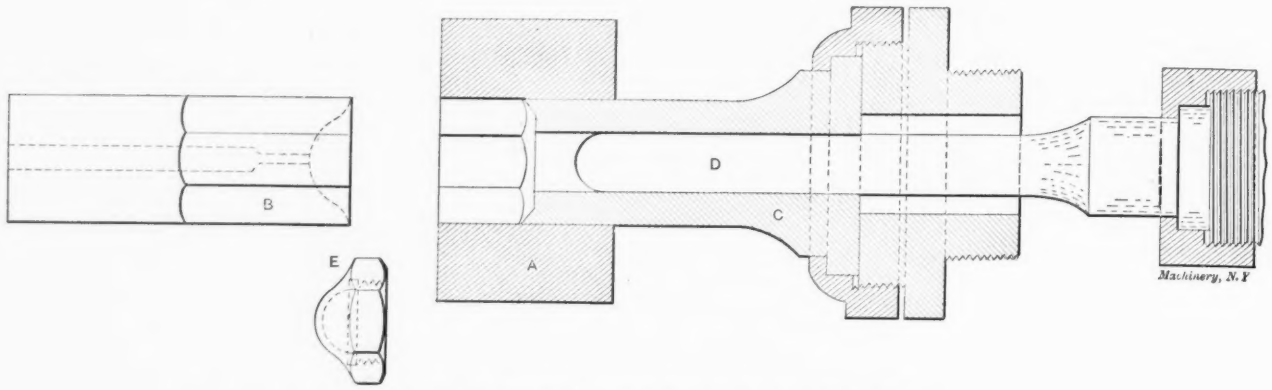


Fig. 2. Another Pattern of Pit Planer built by the Same Concern.

by the Societe Anonyme des Etablissements Fetu-Defize, Liege, Belgium, and is used by such concerns as Fried. Krupp, Essen, Germany; Armstrong, Whitworth & Co., London, England; Dillingen Huttenwerke, Dillingen, for planing armor-plates, conning towers for forts, and other massive work having great weight. The same type of planing machine is used in America by the Bethlehem Steel Co.'s and Carnegie Co.'s armor plants.—EDITOR.]

MAKING NUTS FOR FLEXIBLE STAY-BOLTS.

The accompanying engraving shows a method of making nuts for flexible stay-bolts, which may be of interest to some of the readers of MACHINERY. In the shop where this method is employed, a drop forging press is not available. This device was therefore designed to be used on a 1½-inch Ajax nut machine. The nut blank is placed in a holder *A*, and the die *B* holds it in place. The punch *C* then moves forward and



Device for making Flexible Stay-bolt Nuts on the Ajax Nut Machine.

crowns the nut, and finally punch *D* is fed forward and makes the recess into the blank for the thread, at the same time that the projection is thrown up on the end of the nut. The finished nut is shown at *E*. This process of making nuts proved a complete success, it being possible to make 1,000 in 10 hours.

W. L.

THE USE AND ABUSE OF THE HACK-SAW.

The most useful tool in the tool-room, and, at the same time, the most abused tool of all, perhaps, is the power hack-saw. Nearly every tool-room has one, and every one, from the new apprentice to the "old man" uses it more or less—but how do they use it? In the average shop this tool is not only neglected in so far as cleaning and proper oiling is concerned, but it is misused in almost every conceivable way, and it has occurred to the writer that a few words in the columns of MACHINERY with reference to the proper use of the hack-saw might be instrumental, to some extent, at least, in calling attention to this matter. The following, therefore, contains a few suggestions which will be helpful for getting the best results out of this machine with a minimum cost for hack-saw blades.

When a piece of steel is nearly sawed off, it is poor practice to try to break it off while the saw is running, by working it up and down, because it is likely to break the saw in every instance. The saw should be stopped, and the saw-frame raised first, before any attempt is made to break off the piece.

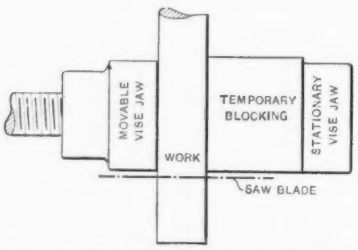


Fig. 1. Temporary Blocking for Using Portion of Saw not yet Dulled.

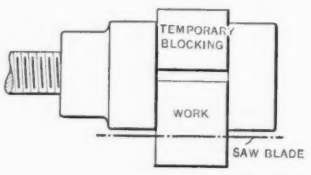


Fig. 2. Blocking for Holding Short Work.

If a piece of steel or iron is sawed through about one-half or three-quarters of its thickness, and the saw blade proves to be too dull to cut through the piece completely, then remove the blade and replace it with a new one, but turn over the piece and start the cut on the opposite side, because a dull saw blade is always worn more or less on the sides, and will always cut a narrower slot than a sharp blade, and if a new blade is forced into the slot already sawed by a dull saw, it will almost always stick, and when started up it is very likely to break.

The duller a saw is, the more pressure or weight should be brought to bear upon it. Whenever the old blade is replaced by a new one, the pressure should be released, to a certain extent, as a sharp blade, with too much pressure back of it, will have a tendency to break. If, by chance, it does not happen to break, it will at least get some of the teeth broken off, which, as far as its usefulness is concerned, to a certain extent, is almost as bad as if the saw itself were broken. This, in fact, is one of the chief causes of the breakage of saws, and it is also a reason why saw blades made by reliable and able makers are pronounced too hard, and discarded, at times, for inferior ones, although the real cause of the breakage ought to be laid to the ignorance and carelessness of the operators.

The writer has often seen saw blades thrown away, that are supposed to be too dull for further use, although they could have been used for a great deal longer time, if the method shown in Fig. 1 had been employed, where that part of the blade is used which has not previously been employed to any great extent. When most of the pieces cut off in the hack-saw are of small diameters, it is often only one small portion of the saw that becomes dull, the remainder being as good as new. The engraving indicates how the piece sawed

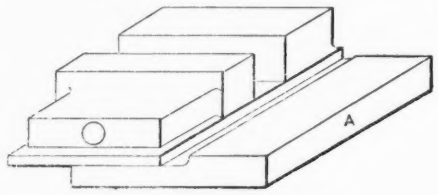


Fig. 3. Shelf for Supporting Portion of Work being Cut Off.

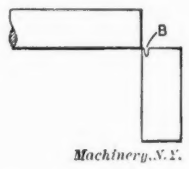


Fig. 4. Effect when End of Work being Cut Off is not Properly Supported.

off is removed from its ordinary position by a temporary blocking between the piece itself and the stationary vise jaw. This, of course, permits the saw to cut with a different portion from that which has previously been employed to do most of the work.

In starting up a saw, it always pays to slightly lift up the saw frame until the blade has made a few strokes and provided a bearing surface for itself in the piece to be cut off. It is evident that in sawing off a piece of square or flat stock, the blade will first come in contact with the sharp corners of the stock, which, of course, give no bearing surface for the saw at all, and the saw will therefore dig in. If, however, the saw is prevented from coming down upon the work with its full weight until a sufficiently long bearing surface for the teeth has been provided, the life of the saw will be greatly prolonged, and a consequent cutting down of the expense of the operation of the hack-saw will follow.

If a bar is to be cut off, always hold it in the vise in such a manner that the greater portion of the bar is between the vise jaws. This will give a good support to the piece. A piece of work that is insecurely held in the vise will always wobble, and this is a frequent cause of breakage of saws. Should a piece be so short that, when placed in the vise, it will not extend over one-half of the length or width of the vise jaws, then place a piece of blocking of the same diameter at the other end of the vise, as shown in Fig. 2, before tightening it. This will tend to permit the vise to hold the work securely, and also prevent injury to the vise from springing or breakage.

If a hack-saw is of a good design, it usually has a projecting shelf similar to that shown at *A*, Fig. 3, which provides for support of the piece to be cut off. Otherwise, when nearly sawed off, the piece will bend over, causing the saw to dig into it, as at *B*, Fig. 4. All hack-saws, however, are not provided with this projecting shelf, and this is rather surprising, as it seems to be a serious defect.

In conclusion, the writer would say that, from personal experience, he believes that the best results are obtained by having all the sawing off, either on the power hack-saw or a cutting machine, done by one man, provided it is seen to that this man knows his business. No one else should be permitted to run the machine. In this way, if anybody is to be blamed for undue carelessness, it is an easy matter to find out who is to blame. Better results are also obtained, from a financial point of view, because a great deal of time is wasted by each man spending a certain time on cutting off his work himself at the hack-saw, when this could as well be done by somebody who is doing this kind of work all the time.

C. F. EMERSON.

WHITWORTH OR ENGLISH TAPER PIPE TAPS.

In the article on Screw Thread Systems in the February issue of MACHINERY, it was mentioned that the manufacturers make the taper on Whitworth or English pipe taps the same as the taper on Briggs standard pipe taps. In the April issue, however, it is also mentioned that in England these taps are made with a 1-inch taper per foot, instead of ¾-inch, and that at least one firm in this country makes these taps with the taper according to this practice. No table, however, is appended, giving any dimensions for English taper pipe taps, when these are made with a 1-inch taper per foot. Mechanical hand-books give nothing on the subject of the taper of Whitworth pipe taps, and for that reason it is highly desirable that the question of correct taper be brought up in the discussion of this subject. The dimensions of these taps should be based upon standard Whitworth pipe tap gages, which are made in England by the Whitworth Company. These gages all taper 1 inch to the foot and are so marked upon the gage.

The accompanying table shows the dimensions of Whitworth pipe taps, as made by the A. J. Smart Mfg. Co. It will be noticed by comparing this table with the one appearing in the March issue of MACHINERY, for regular Briggs pipe taps, that the diameters at the small end are not the same for the same nominal sizes. This is because English pipe is smaller than American pipe, according to all tables, so that the ends on the Whitworth pipe taps should be made correspondingly smaller. It is believed by the A. J. Smart Mfg. Co. that the proper way to make the taps, therefore, is to make the diameter at the smaller end correspondingly smaller. The lengths of the pipe taps in the table will also be found to be shorter, because it has been found that all users of pipe taps, especially plumbers, prefer the shorter lengths, and many of the tap manufacturers are now making the lengths of the threaded part of pipe taps the same as those given in the table. The A. J. Smart Mfg. Co. also only makes 4 or 6 flutes in its taps. The company has found that customers do not like an odd number of flutes, as the taper with the odd number of flutes can never be measured by micrometers after the flutes have been once milled. This is a great disadvantage (or, to some people, an advantage) in cases of disputes as to the sizes of the taps. In the table given, there will be found a column giving the size of the steel used for the different taps. This information is given for the convenience of the purchasing agent, the superintendent, the foreman, etc., and has often been found exceedingly useful.

CHARLES E. SMART.

Greenfield, Mass.

TABLE OF WHITWORTH PIPE TAPS.

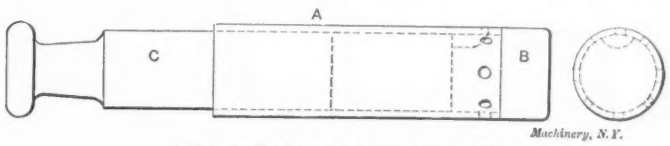
(A. J. Smart Mfg. Co.'s Standard.)

Taper per foot = 1 inch.

Nominal Size.	Diameter at Large End of Thread.	Total Length of Tap.	Length of Thread.	Length of Shank.	Diameter of Shank.	Length of Square.	No. of Threads per inch, Whitworth Form.	Number of Flutes.	Size of Steel.
1/8	0.435	2 1/8	1	1 1/8	0.328	11/32	28	4	15/32
1/4	0.570	2 3/8	1 1/4	1 1/4	0.438	7/16	19	4	19/32
3/8	0.718	2 5/8	1 5/16	1 5/16	0.563	1/2	19	4	3/4
1/2	0.888	3	1 7/16	1 9/16	0.703	9/16	14	4	59/64
5/8	0.964	3 1/4	1 15/32	1 25/32	0.781	5/8	14	4	1
3/4	1.103	3 3/8	1 1/2	1 7/8	0.906	11/16	14	4	1 9/64
1	1.382	3 1/2	1 5/8	2 1/8	1.125	13/16	11	4	1 13/32
1 1/4	1.725	4 1/8	1 7/8	2 3/8	1.453	15/16	11	6	1 3/4
1 1/2	1.958	4 3/8	1 7/8	2 1/8	1.609	1	11	6	1 63/64
1 3/4	2.130	4 1/2	2 5/16	2 5/16	1.766	1 1/16	11	6	2 5/32
2	2.430	4 5/8	2	2 5/8	2.063	1 1/8	11	6	2 15/32

DEVICE FOR MAKING WAX FILLETS.

The device for making wax fillets, described by M. R. Kavanagh in the December, 1907, issue of MACHINERY, is a good thing for a pattern-maker to own, but it may be made as shown by the accompanying illustration with less trouble and expense. The barrel *A* is a piece of brass tubing. The cap *B*



A Simple Tool for Making Wax Fillets.

and the plunger *C* are both made of hard wood. Eight different sized holes are drilled near one end of the tube, all but one being covered by that part of *B* which extends into the tube, as shown. Any other hole may be uncovered by turning *B*. To produce a fillet, fill the barrel with wax, warm, and compress in a vise.

W. H. KNOWLES.

New Britain, Conn.

METHOD OF MAKING SCREW FOR DRILL CHUCK.

Some time ago I had occasion to replace a screw in the Standard Tool Co. drill chuck, and as we did not have any in stock, one had to be made as soon as possible. I gave the job to a tool-maker working under me, and asked him how long it would take to make it, and he said about one hour

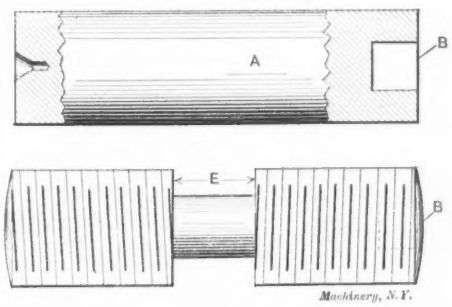


Fig. 1. Two Views of the Partly Finished Chuck Screw.

and a half. I doubted his word, somewhat, on the time, but told him to go ahead, and in less than an hour and a half he handed me the chuck repaired with a good hardened screw, and as true as the day it came from the factory. This is a job that a tool-maker does not have very often, as these screws

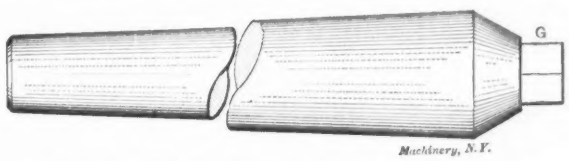


Fig. 2. Lathe Center for Holding and Driving the Work.

are usually replaced by ordering from the factory, but at the same time, when there is one needed and there is none in stock, it is usually a hurry-up job, and it is very important that we should know how to get it out in good time.

Referring to Fig. 1, the first operation is to cut off a piece of stock *A* long enough to make the screw, allowing a little

stock for finish on both ends; then broach in the square hole *B*, and center the other end. Then it is ready to be turned and threaded as shown. It is also necessary to have a lathe center such as shown in Fig. 2, with a square *G* to fit the hole *B* snugly, the square also acting as driver. Then with a parting tool, cut groove *E* (Fig. 1) about ⅛ inch narrower than it is to be when finished. Then the piece is ready to be threaded. Cut the thread right- and left-hand, using the broken screw for thread dimensions. It is not necessary to take any care in starting threads in the right position, in order to have the jaws come central in the chuck.

After the threads have been finished to size, chuck jaws *D* (Fig. 3) are set in place on the screw and turned around until they come firmly against center pin *H*. The groove *E* can then be made perfectly central with the working faces of the chuck jaws by setting the parting tool with the pin *H*, which is held between the jaws. After the tool has been set in this way, and one side of the groove *E* has been faced, the jaws may be put on the screw again in the same position, and the tool set for facing the opposite side of the groove.

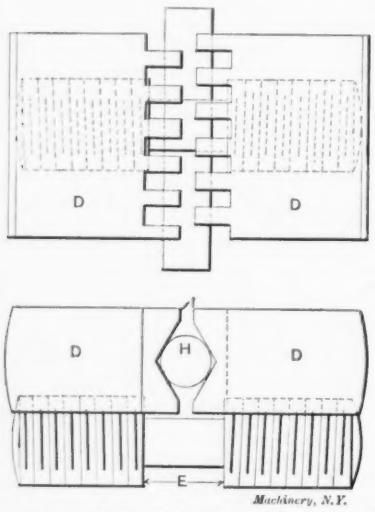


Fig. 3. Method of getting the Groove E and the Working Faces of the Chuck Jaws Central.

It may seem useless to the reader to use the center pin *H*, as it would be just as well to use the chuck jaw at *I* to obtain the center of the groove *E*, but that will not hold good in all cases, as sometimes you will find that the surface *I* is not true with the part of the chuck jaw that holds the drill. In order to be on the safe side, it is wise to take the measurement from the working part of the chuck jaw. It does not matter whether the chuck is old or new, groove *E* is bound to be central with the working face of the jaw. One thing I would like to say in conclusion is that it is wise to have a piece of steel on hand suitable for making screws, as most carbon steel used for reamers, taps, etc., would be too high in carbon to give good results on screws where there is a twisting strain, such as chuck screws.

B. M. Weller.

Franklin, Pa.

HARDENING OF HIGH SPEED STEEL VERY IMPORTANT.

Referring to your remarks anent high speed steel for milling cutters (page 453, engineering edition, March issue), users of steel must not confuse "hardness" and "red-hardness." Further, some steel tools last longer than others without re-grinding, on cast iron; while on steel or wrought iron it is the other way about. Too many steel users mix the terms "self-hardening" and "high speed"; also, they consider that all high-speed steel is alike; whereas, there are more sorts thereof (I don't mean brands) than there are of ordinary "binary" or carbon tool steels. The lasting propensity of a tool steel is more dependent on the hardening process than on the manufacturer; and more on the hardener (man) than either.

Robert Grimshaw.

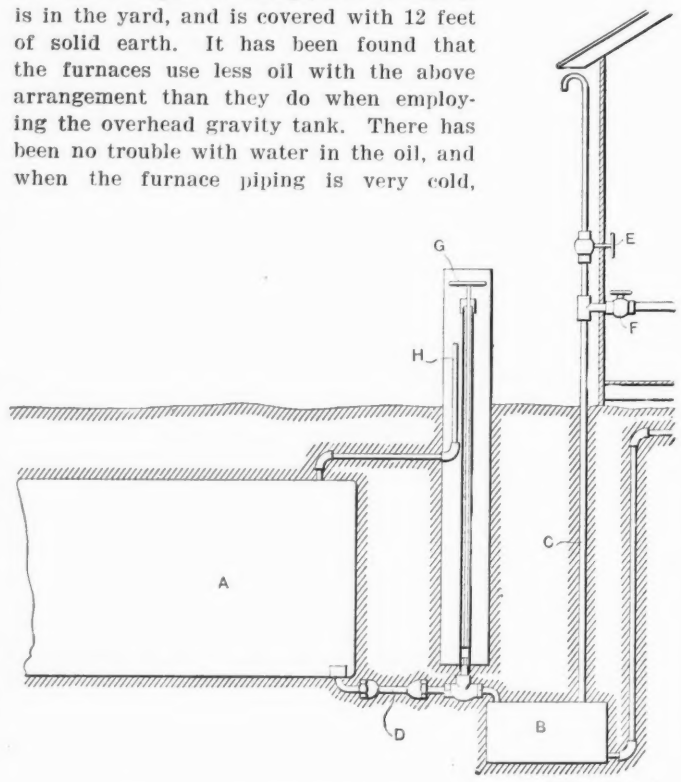
Dresden, Germany.

FUEL OIL STORAGE SYSTEM.

Most oil storage systems are arranged so that the oil will flow by gravity to the places where it is required. This, however, necessitates having the oil tank elevated, and considerable danger is connected with this system. In order to eliminate this danger, the arrangement shown in the accompanying engraving was resorted to by a foundry in the middle West. The object of the arrangement shown is to place all oil below the ground, and to keep it there unless it is forced away from its reservoirs by means of air pressure. As will be seen from the following description, all pumping of oil is eliminated, and at the same time the danger of carrying air pressure on a large storage tank for oil is avoided.

The arrangement consists of a large storage tank *A*, which is 35 feet long and 8 feet in diameter. This storage tank is filled directly from a tank car at that end of the storage tank not shown in the engraving. The small tank *B*, from which the oil is fed to the places where it is used, by means of air pressure, is connected with the storage tank *A* through the piping *D*. This tank is 5 feet long by 2½ feet in diameter. When it is required to fill the tank *B*, the vent valve *E* is opened and the air pressure valve *F* closed. The tank *B* will then be filled, by gravity, in six minutes. The valve *G* and the vent valve *E* are now closed, and the high pressure valve *F* opened, permitting the air pressure to be applied on the oil in tank *B* through pipe *C*. Then, if such furnace valves as required are opened, the oil will flow to the places where wanted, actuated by the air pressure on the oil in tank *B*. It is impossible to get any air pressure on the oil in the large tank on account of this tank having a vent pipe *H* which cannot be closed, and the security is all the greater as the air pressure pipe to tank *B* is smaller in diameter than the vent pipe *H*, so that if valve *G* should be left open, the air will escape directly into the atmosphere through the pipe *H*. When the pressure valve *F* is closed and the vent valve *E* opened, leaving all furnace valves as they are in operation, all oil in the pipes in the shaft will return by gravity at least 36 inches below the floor of the shop.

If, after several years of use, the pressure tank should be weakened through corrosion so that it would rupture, this could do no special damage, as the tank *B* is in the yard, and is covered with 12 feet of solid earth. It has been found that the furnaces use less oil with the above arrangement than they do when employing the overhead gravity tank. There has been no trouble with water in the oil, and when the furnace piping is very cold, no heating of the same has been required, as was formerly the case, because the oil is comparatively warm in the underground tanks, and, having a pressure of 60 to 80 pounds per square inch, it always finds its way to the furnaces. It should be noted that it is important that a lead pipe be used for connecting the two tanks, permitting each tank to settle independently.



Economical and Safe Storage System for Fuel Oil.

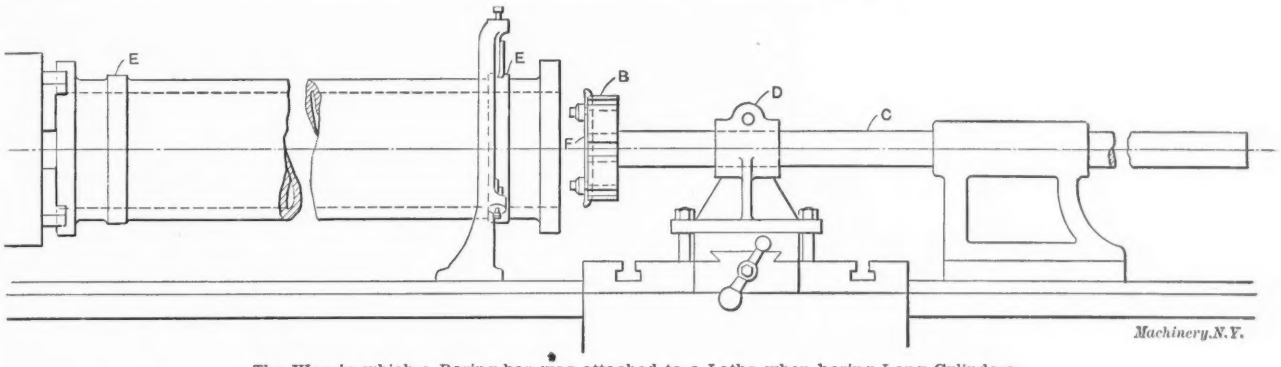
The valve between the two tanks *A* and *B*, which is operated by the hand-wheel *G*, is placed in a box with locked cover. This box enters in the ground so that it comes down close to the valve seat. The vent pipe *H* is also placed inside of this wooden cover, and ten ½-inch holes bored in the side of the box to permit free circulation of the air.

Racine, Wis.

E. Falkenrath.

BORING LONG CAST IRON CYLINDERS.

We had some cast iron cylinders to bore, and as they were ten feet long, and were to be bored twelve inches in diameter, we were obliged to make a special boring tool. The sketch shows this tool, and the way in which it was attached to a lathe. The boring head *B*, which is keyed to the bar *C*, has six dove-tailed slots cut across its periphery. These slots were for holding hard wood blocks which fitted closely into the bore, guiding the bar. A double-ended boring tool was clamped in the groove across the head, as shown at *F*. The split sleeve



The Way in which a Boring-bar was attached to a Lathe when boring Long Cylinders.

D, which was fastened to the lathe carriage, supported one end of the boring-bar, and the sleeve was clamped to the bar when boring, as the feeding was done by the lathe carriage. The bar was also supported by the tail-stock as shown. Before the boring-bar was placed in position, the enlarged parts *E* of the cylinder were trued up, as the outer end of the cylinder had to be supported by a steady-rest.

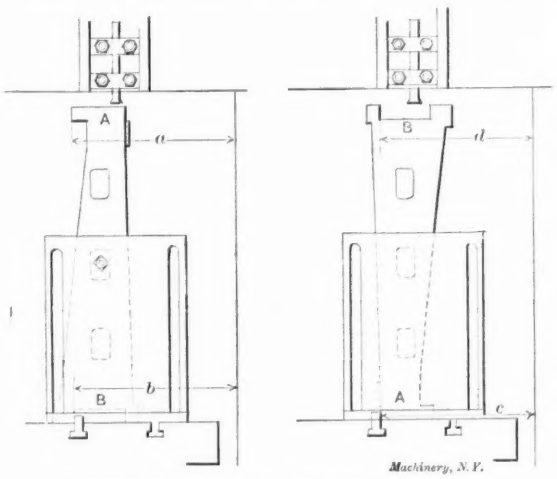
In starting the cut, it was necessary to steady the bar by clamping the sleeve nut *D* close to the boring head, but when the head had entered the cylinder, the sleeve was moved out as far as the tail-stock would permit, and again clamped to the bar. In starting this job, the double-ended boring tool and hard wood block referred to, were used. It was found, however, that by using a single tool, and by inserting hardened steel blocks in the two slots opposite the tool, much better work could be done, because in the former case the blocks were rapidly worn away. Of course, it was necessary to adjust these blocks for each cut. The cylinders bored in this way were approximately straight and true, and the work entirely satisfactory.

M. B. STAUFFER.

Scottdale, Pa.

METHOD OF PLANING AN ODD-SHAPED CASTING.

Referring to the accompanying engraving, it is necessary that the end *A* and the socket *B* be interchangeable with another end and socket, and that the parts,



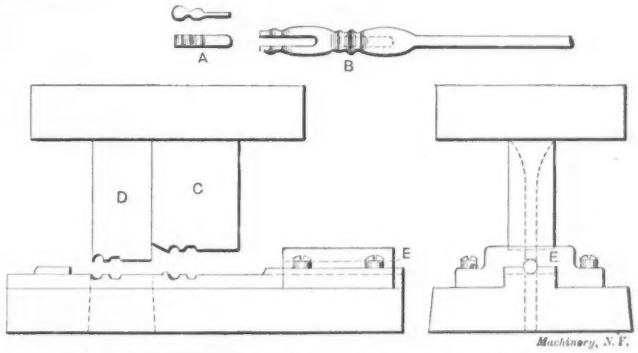
Figs. 1 and 2, showing the Work set up on the Planer.

when in position, line up the same when the extension is in use, as when it is removed and the other end and socket are in position. The length of the extension is such that a very small variation at either end would be sufficient to cause a serious variation at the other end. After several attempts to plane the casting with sufficient accuracy, the following method was decided on as giving the best results: The casting was placed on the planer table with the end *B* down, and with one side of the slot against a tongue inserted in the table slot. The casting was then set with the planer housing by measuring at *a* and *b*, adding enough to *a* and subtracting enough from *b* to allow for finishing. After the end *A* was finished to the required dimensions, the casting was inverted, as shown, and the finished edge placed against the tongue piece in the table. A micrometer measurement *c* was then taken from the tongue to the housing, and one side of the slot in the end *B* of the casting finished to this measurement as at *d*. In this way the finished surfaces at each end of the casting were made parallel, and in the same plane.

LEROY K. MOULTON.

A SWAGING AND BLANKING DIE.

A few years ago, I had some small pieces to make as shown at *A* in the engraving. These pieces, I believe, hold the sapphires used on phonographs. The job puzzled me a bit until I hit upon the scheme of running an annealed brass wire through a gang die, and swaging and blanking the pieces from this. At *B* is shown the end of the wire after the swaging and blanking punches have done their work. The swaging punch is shown at *C*, while *D* is the punch that forces the blank



Swaging and Blanking Die for Forming the Pieces shown at A.

through the die. The wire is fed through the guide *E*, which keeps it in proper alignment with the working faces of both die and punch. The dotted lines, shown on the swaged end *B* indicate where the next piece *A* will be cut from the stock by the blanking punch *D*. A stripper (not shown) removes the scrap from the blanking punch. The pieces, after coming from the die, are tumbled and then drilled.

New York. JAMES J. KLEIN.

CUTTING OFF STEEL SHAFTS.

The following little kink may be appreciated by many machinists who have had more or less trouble when cutting off steel shafts. By simply turning the cutting-off tool upside down, and running the lathe backwards, it is possible to almost entirely eliminate any digging in of the tool. This method will be found to be far superior to the ordinary method of cutting off stock. Of course, it works to best advantage when using a straight cutting-off tool. It is necessary that the lathe be reversed; or else, if the cross slide permits of the tool being placed on the opposite side of the lathe, in the rear, then the reversing is of course unnecessary.

Birmingham, Ala. JOHN MCLEOD.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

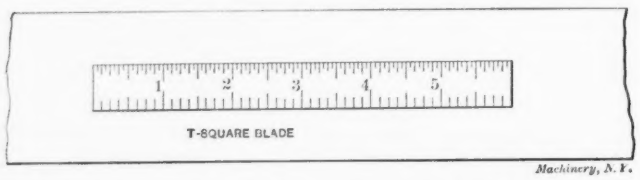
MAKING KNURLS.

A very satisfactory method of making the common knurls, when no other means is at hand, is to turn up the flank in a lathe, then place it in the holder and insert the holder in the tool-post of a shaper. Next clamp a sharp, flat mill file in the shaper vise, flat side up, and run the knurl blank back and forth over it until teeth sufficiently deep are cut. By using a wide file, and shifting the shaper vise, knurls having teeth varying from a considerable angle to those straight across may be obtained. Instead of a file, a specially cut piece of hardened steel is often used. After the knurls are cut, they are hardened and tempered in the usual way and are then ready for use. ETHAN VIALL.

Decatur, Ill.

STEEL RULE RECESSED INTO T-SQUARE BLADE.

The following little kink may be of some value to those readers of MACHINERY who are draftsmen. A 6-inch flexible Brown & Sharpe scale is laid into the T-square blade, which has previously been recessed somewhat to fit the scale, as shown in the accompanying engraving. Shellac is used to



Machinery, N. Y.

hold the scale in place in its recess. The dividers and compasses may be set directly from this scale, and the annoyance of looking for an ordinary loose draftsman's scale is avoided. Scales graduated to 32ds and 64ths of an inch are convenient for fine work. The writer has found that the Brown & Sharpe scale fitted in this way is very handy. JOHN COAPMAN.

Rochester, N. Y.

A TAPER TURNING KINK.

The usual way of turning a taper in a lathe without using a taper attachment is to set over the tail-stock and use the same centers as are used for straight work. This gives an uneven bearing on the centers, thus wearing the centers away, as can be readily seen from Fig. 1. This method is likely to spoil accurate work. Fig. 2 shows a simple and inexpensive way of overcoming these bad points. All that is necessary

Fig. 1

Fig. 2 *Machinery, N. Y.*

is to turn up two female centers and put bicycle balls in them. They need not be fastened, as a little oil is sufficient to stick them in place while the work is being put in the lathe. S. A. MCDONALD.

Candiac, Canada.

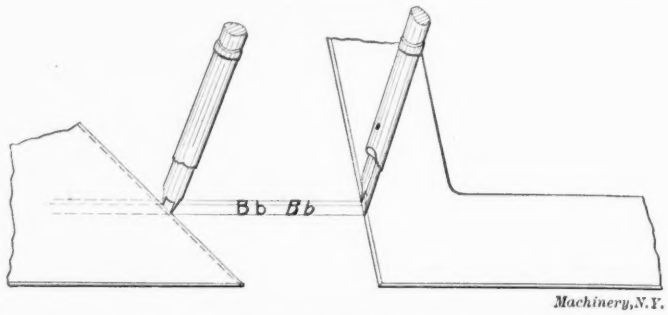
A NEW TRICK IN CAT-HEADS.

Every machinist has had to use some kind or variety of cat-head, and generally when using this same indispensable cat-head, the frame of mind of that same machinist is anything but dee-lighted. The other day I saw a simple method of making a cat-head which made me feel like bumping my head against a brick wall for not thinking of it when I required one for my own use. The man had two levers about four feet long, which had to be turned and machined to a special shape at one end, and the other end was turned round nearly one-half the length of the lever. He procured a bushing which had a hole about ½ or ⅝ inch larger than the diagonal of the lever, and using this as a mold, poured a babbitt cat-head on each of the levers. He used the same bushing on both levers, and then took a light cut over both cat-heads, making them the same outside diameter. Then he adjusted his steady-rest to the cat-head, and finished the job with a smile on his face. J. J. VOELCKER.

Decatur, Ill.

HANDY TOOLS FOR THE DRAFTING BOARD.

If a great deal of lettering has to be done on a drawing, it is convenient to have a gage for a uniform height of the letters. Such gage can conveniently be made of an ordinary pen point, by breaking off the two points and using the two remaining points as a gage. For the height of the capital



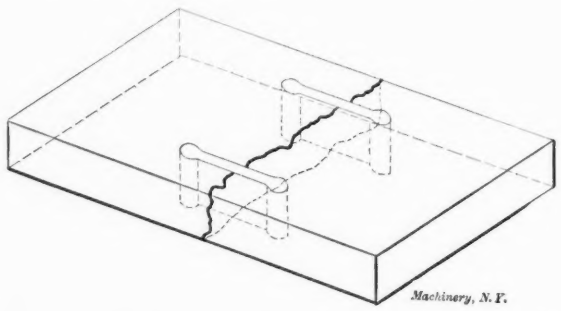
Machinery, N. Y.

letters point off their space along the vertical side of a 45-degree triangle, and for the height of the small letters use the gage along the inclined side of the same triangle, which will give the right proportion, as shown. I always keep on hand a number of broken-off pen points of various sizes for different gages. MARTIN JOACHIMSON.

New York.

A DUMB-BELL PATCH.

A simple application of a repair "stunt" called a dumb-bell patch, that does not seem to be widely known, is shown in the engraving. The patch, or more properly, the link, gets its name from the resemblance it bears to the dumb-bell, and finds a field of usefulness in joining the parts of a broken casting



Machinery, N. Y.

that must be held as near as possible to their original position and have no screw heads or indentations in the finished surface. This is accomplished as follows: The broken pieces are put closely together, and the place for the dumb-bell is laid out, after which the casting is drilled and slotted to these lines. A piece of steel is then carefully worked up to fit this opening, but with the distance from center to center of the round ends slightly less than the drilled holes for the dumb-bell. The piece is heated until it is long enough to be driven home, and while cooling, it is riveted slightly to fill perfectly all around, after which the patch can be filed off flush. By this method the broken parts will be held together with considerable force. DONALD A. HAMPSON.

Middletown, N. Y.

* * *

In the May issue we published an article on the "Shop Kinks" page, by Mr. J. J. Voelcker, on the use of the steady-rest. The illustration accompanying this article did not show a driver attached to the work, but, of course, it will be understood that the only function of the leather strip is to hold the work against the head-stock center.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

DEFINITION OF MACHINE TOOLS.

C. L. B.—Please define machine tools.

A.—A strict definition of machine tools is difficult, if not impossible. A machine tool is a metal-working machine, but not all metal-working machines are machine tools, by any means. The standard machine tools are engine lathes, turret lathes, chucking lathes, pulley lathes, screw machines, planers, shapers, slotters, milling machines, gear cutters, gear planers, boring mills, boring machines and drilling machines, these being the chief examples. Then follow key-seaters, broaching machines, nut-tappers, centering machines, bolt threaders, hack-saws, cam cutters, profilers, etc., which are on the borderland. A broad definition of machine tools would include these also, but the narrower sense in which the term is commonly used, does not include them.

CHANGE GEARS FOR MILLING MACHINE WHEN CUTTING SPIRALS.

Machinist.—In the January issue you explained, in a simple manner, to "Apprentice," how to figure change gears for the lathe. I would be pleased if you would explain, in a similar way, how to figure change gears for the milling machine, when cutting spirals.

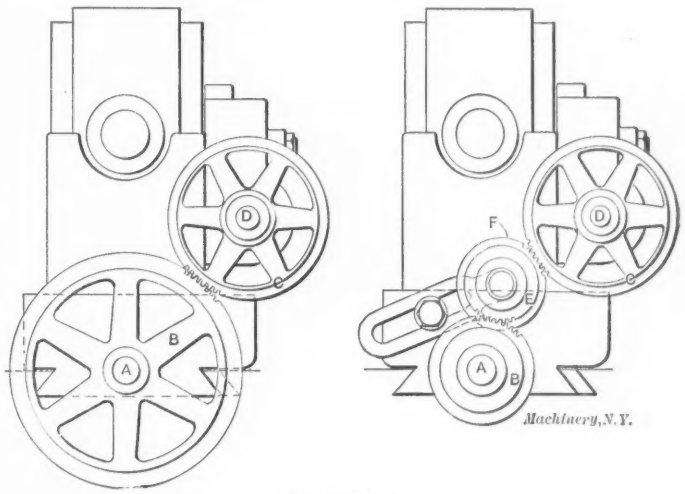
A.—The method for the figuring of change gears for cutting spirals on the milling machine, is, in principle, exactly the same as that used for figuring change gears for the lathe, but it will be necessary to shortly refer to the construction of the mechanism for connecting the index head spindle and the feed-screw to make perfectly clear the fundamental ideas governing the selection of change gears. In Fig. 1, *A* is the feed-screw of the milling machine, and *B* is the gear placed on this feed-screw, commonly called the feed-screw gear. This gear meshes with the gear *C*, placed on the stud *D*, from which, in turn, motion is imparted to the worm in the index head and from the worm to the worm-wheel and the index spindle. The gear *C* on the stud *D* is called the worm gear, because it directly operates the movement of the worm. This expression "worm gear" should not be confused with the worm-wheel, which is placed on the index spindle. The case shown in Fig. 1 is one of simple gearing. In Fig. 2 is shown a case of compound gearing. Here *B* still represents the feed-screw gear, *E* is a gear on the intermediate stud, meshing with gear *B*, and gear *F* is another gear on the same intermediate stud, meshing with gear *C*, thus transmitting motion from the feed-screw to the stud *D* by compounding the gears.

The figuring of change gears for the milling machine consists simply in the selection of the proper gears, *B* and *C*, used in a simple train, as in Fig. 1, or gears *B*, *E*, *F* and *C*, as used in a compound train of gears, as shown in Fig. 2.

In order to figure change gears for the lathe, we remember that it was necessary to first know the number of threads per inch in the lead-screw. Knowing that, we knew how many revolutions the lead-screw had to make to move the carriage and the thread tool one inch along the work. In the case of the milling machine we must know *how far the table travels while the index spindle makes one complete revolution, when gears B and C, Fig.* 1, *have an equal number of teeth*. This distance is the constant which we used in figuring the change gears, the same as we used the number of threads per inch of the lead-screw in figuring change gears for the lathe. This constant, which may be different for different milling machines, is called the *lead of the milling machine*. We will now see how this constant is found.

Suppose, for instance, that in a milling machine one revolution of the worm gear *C*, Figs. 1 and 2, will produce exactly one revolution of the shaft on which the worm is placed, that is, one revolution of the index crank; and suppose that equal gears are placed on the feed-screw and on the stud *D*, so that one revolution of the feed-screw produces exactly one revolution of the gear *C* and stud *D*. Then, if the feed-screw revolves one revolution, the milling machine table will advance a distance equal to the lead of the feed-screw, because, as we have said before, the lead of the screw is the distance which it will advance in one turn.

Now, when the table of the milling machine moves forward a distance equal to the lead of the feed-screw, or a distance equal to one thread in the feed-screw, the feed-screw turns one revolution, and gear *C* also turns one revolution, the worm-shaft and the index crank turn one revolution, and, there being 40 teeth in the worm-wheel which is mounted on the index head spindle, this worm-wheel, with its spindle, will turn 1/40 of one revolution. To make one complete revolution of the index head spindle, the feed-screw would have to be revolved as many times as there are teeth in the worm-wheel, each revolution, as we have seen, moving it one tooth. The distance which the milling machine table will advance, when the index head spindle revolves one complete revolution, is, as we have said, the lead of the machine. This distance evidently equals the distance that the feed-screw advances the table in one revolution (which is the lead of the screw) times the number of revolutions made. If we assume that the feed-screw has a lead of ⅛ inch, and that there are 40 teeth in the worm-wheel on the index head spindle, the feed-screw, when the gears *B* and *C* are equal, will have to turn 40 times, in order to move the index head spindle around once, and the distance the table will then advance will be



Figs. 1 and 2.

40 times ⅛ inch, or 5 inches. In this particular case, 5 inches is then *the lead of the machine*. If now a piece of work had been affixed to the index spindle, it is clear that this piece of work would have made one complete revolution, while the milling machine table advanced 5 inches, and that the lead of the spiral cut on the work would have been 5 inches.

A general rule for finding the lead of a milling machine may be stated as follows: *To find the lead of a milling machine, place equal gears on stud D, Fig.* 1, *and on the feed-screw, and multiply the number of revolutions made by the feed-screw in order to produce one revolution of the index head spindle, by the lead of the feed-screw.*

Suppose, for an example, that it is necessary to make 40 revolutions of the feed-screw in order to turn the index head spindle one complete revolution, when gears *B* and *C*, Fig. 1, are equal, and that the lead of the feed-screw of the milling machine is ¼ inch, then the lead of the machine equals $40 \times \frac{1}{4}$ inch, or 10 inches.

This rule just given is general, and will apply even if the number of teeth in the indexing worm-wheel were different from that in standard indexing heads, because, in the rule, no consideration is taken of the number of teeth of the worm-wheel directly, but simply the number of turns made by the feed-screw to correspond to one turn of the index spindle itself.

If it is now perfectly clear that the lead of the machine means the distance which the table of the milling machine must move forward in order to turn the work placed on the index head spindle around one complete revolution, it is easy to understand that if we want to get a spiral that is twice as long as the lead of the machine, then we must place gears on the feed-screw and on the stud *D* of such size that

the indexing spindle will only turn half a revolution while the table moves forward a distance equal to the lead of the machine. Suppose, for instance, that we want to cut a spiral, having a lead of 20 inches, that is, making one complete turn in a distance of 20 inches, and that the lead of the milling machine is 10 inches. Then, while the table moves forward 20 inches, we want the indexing spindle to turn once. In order to make the table move forward 20 inches, when the indexing spindle turns around once, the feed-screw evidently must turn twice as many times as it did in the case when the table only moved 10 inches for one turn of the index spindle, in which case we had equal gears on the feed-screw and on stud *D*; consequently the two studs or shafts, *A* and *D*, must be so connected that one will turn twice as fast as the other. The ratio between the speeds then is 2 to 1, which means that the feed-screw, which is required to turn twice while the stud *D* turns once, must have a gear that has only half the number of teeth of the gear placed on stud *D*.

If the lead of the machine be 10 inches, and the lead required to be cut on the piece of work is 30 inches, then it would be necessary to have the ratio between the gears 3 to 1, which, of course, is the same as the ratio between the lead of the machine and the lead of the spiral to be cut (30 to 10 equals 3 to 1). We can therefore express the rule for finding the change gears by a simple formula:

$$\frac{\text{lead of spiral to be cut}}{\text{lead of machine}} = \frac{\text{number of teeth in gear on worm stud } (D, \text{ Fig. 1})}{\text{number of teeth in gear on feed-screw}}$$

Expressed as a rule, this formula would read: *To find the change gears to be used in a simple train of gearing, when cutting spirals on a milling machine, place the lead of the spiral in the numerator and the lead of the milling machine in the denominator of a fraction, and multiply the numerator and denominator with the same number, until a new fraction is obtained in which the numerator and denominator give suitable numbers of teeth.*

As an example of the above rules, we will take the case of a milling machine in which we have found that there are 4 threads per inch on the feed-screw, and that 20 revolutions of the feed-screw are necessary to make the index spindle turn one complete revolution when having equal gears on *A* and *B*, Fig. 1. On a machine of this kind, assume it is required to cut a spiral the lead of which is 12 inches. The first thing for us to do is to find the lead of the machine. This, as we have already said, is equal to the revolutions of the feed-screw necessary to turn the index spindle one revolution, multiplied by the lead of the feed-screw. As the feed-screw has 4 threads per inch, the lead of the feed-screw is ¼ inch, and this, multiplied by 20, gives us $\frac{1}{4} \times 20 = \frac{20}{4} = 5$. To find our gears we now place the lead of the spiral in the numerator of a fraction and the lead of the machine in the denominator, and multiply both numerator and denominator with the same number until we get a new fraction, in which the numerator and denominator express a suitable number of teeth. Following this rule, we have then:

$$\frac{12}{5} = \frac{12 \times 6}{5 \times 6} = \frac{72}{30}.$$

The gear with 72 teeth is placed on stud *D*, which, of course, is required to revolve slower than the feed-screw, in order to cut a spiral which is 12 inches, when the spiral cut with equal gears is only 5 inches, or equal to the lead of the machine. The gear, having 30 teeth, is placed on the feed-screw. If it should be necessary to put an intermediate gear between the gear on the feed-screw and the gear on stud *D*, the number of teeth in this intermediate gear has no influence whatever on the ratio of the speed of feed-screw *A* and stud *D*, but serves simply the purpose of transmitting motion from the one gear to the other.

Compound Gearing.

If it is not possible to find a set of two gears that will transmit the motion required, it will be necessary to use compound gearing. In this case the manner of getting the compound gears is exactly the same as that of getting compound gearing for the lathe. We have already explained that the lead of the spiral to be cut is placed in the numerator of the fraction, and the lead of the milling machine in the denominator. We then divide this numerator and denominator into two factors, the same as we did in the case of figuring lathe change gears, and, having divided them into two factors, we multiply each two of these factors by the same number, exactly as before, thus getting the gears we require. As an example, let us suppose that the lead of a certain machine is 10 inches, and that we wish to cut a spiral the lead of which is 60 inches. We then have:

$$\frac{60}{10} = \frac{6 \times 10}{2 \times 5} = \frac{(6 \times 15) \times (10 \times 8)}{(2 \times 15) \times (5 \times 8)} = \frac{90 \times 80}{30 \times 40}$$

The gear having 90 teeth is placed on the stud *D*, and meshes with the 30-tooth gear *F* (see Fig 2) on the intermediate stud; on the same intermediate stud is then also placed the gear having 80 teeth, which is driven by the gear having 40 teeth placed on the feed-screw. This makes the gears having 90 and 80 teeth the driven gears, and the gears having 30 and 40 teeth the driving gears, the whole train of gears being driven from the feed-screws of the table.

In general, for compound gearing it may be well to remember the rule given by the formula:

$$\frac{\text{lead of spiral to be cut}}{\text{lead of machine}} = \frac{\text{product of driven gears}}{\text{product of driving gears}}$$

* * *

MACHINE SHOP PRACTICE.*

MACHINING A FIXTURE CASTING—2.

This article on machining a milling machine fixture casting is a continuation of the one published in the May issue of MACHINERY. As there stated, this operation was selected as an example of planing, boring, and milling work. The planing operation was discussed, and we shall now deal with boring the bearing and milling the T-slot in the arm. This casting, which is shown on the Shop Operation Sheet Supplement, is the main part of a fixture used for holding lathe chucks while milling the jaw slots. These chucks are mounted on a spindle which is inserted in the bearing of this fixture, and, as this bearing must be in perfect alignment with the table, the boring is done on the milling machine. The casting is shown set up for boring, on operation sheet No. 64 of the Supplement. Before setting the planed surface of the base against the table, care should be taken to see that both table and base are thoroughly clean, as otherwise inaccurate work will be the result. The recognition of the importance of such small matters is very essential in connection with shop work, and, in many instances, such recognition constitutes the real difference between a good and poor workman.

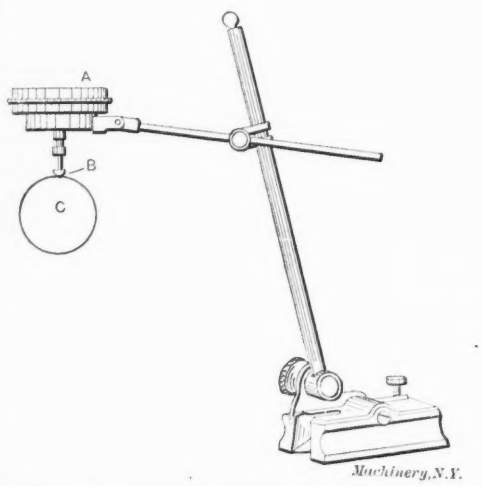


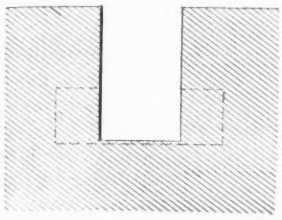
Fig. 1. Test Indicator attached to a Surface Gage and applied to the Boring-bar.

After the boring-bar is inserted in the spindle, a test indicator should be applied to the outer end of the bar as shown in Fig. 1. The indicator *A* is attached to a surface gage which rests on the table, and the contact point *B* of the gage is placed against the revolving bar *C* which, if not in perfect alignment with the spindle, will cause the hand on the gage dial to vibrate, the amount of vibration, of course, depending upon the amount that the arbor is out of true. When adjusting the center of the outboard bearing to the end of the arbor,

* With Shop Operation Sheet Supplement.

care should be taken not to spring the arbor out of alignment with the spindle. The arbor is now set to height by adjusting the knee of the machine vertically, and central with the bosses on the casting by adjusting the table longitudinally. The tool should be set for the first cut so that every part of the hole will be trued up, provided this would not mean too heavy a cut; this is done to prevent the tool from being dulled by the abrasive action of the scale.

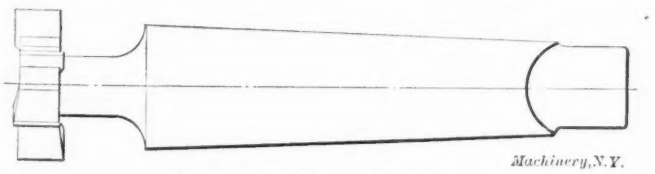
After the hole has been bored to size, we come to the final operation of milling the T-slot. The casting should remain in the same position as for boring while the neck of the T-slot is milled with a plain axial cutter, which should remove as much metal as possible in order that the more delicate T-slot cutter shall have a minimum amount of work to perform.



Machinery,N.Y.

Fig. 2. The First Cut in Forming a T-slot.

A plan view of the work set up on the milling machine table is shown on Shop Operation Sheet No. 65. A right-hand cutter should be used, the direction of rotation being indicated by the arrow. The work will then be fed against the rotation of the cutter, which is preferable, because when the feeding is with the rotation, the cutter is liable to dig into the work, especially if there is any play between the nut and feed-screw. In order to tell whether a cutter is right- or left-handed, notice, when looking at it from that side which is next to the spindle, whether it must revolve to the right or to the left when working; if to the right, it is right-handed, and if to the left, left-handed. After the neck of the T-slot is finished, as shown in Fig. 2, the casting is set up for the final cut as shown on Shop Operation Sheet No. 66. A standard T-slot cutter such as shown in Fig. 3 is used. These cutters have alternate teeth cut on the inner and outer sides, though on some cutters used for this purpose these are omitted, the faces being ground slightly concave. The shank of the cutter should be perfectly clean before it is inserted in the spindle of the machine, and the cutter should be driven tightly in the spindle by tapping it with a soft hammer. All milling cutters which are held by their shanks, and are not supported by the center of the outboard bearing, should be fixed tightly on the spindle as there is a tendency for cutters of this kind to work loose, owing to the vibration due to the cut, which might result in both work and cutter being spoiled. Both cuts for the T-slot might have been taken at this setting of the work by using an end mill for machining the neck of the slot, but in that case a cutter somewhat smaller in diameter than the width of the neck should be used first, as a cutter of this kind, being light, will spring, which would cause the work to be untrue if the neck were finished at one cut. In milling slots of this kind it is preferable, when possible, to



Machinery,N.Y.

Fig. 3. A Standard T-slot Cutter.

first use an axial cutter because, owing to its greater rigidity, a coarser feed can be used and the work can be finished in less time.

[An axial cutter is one that has teeth on surfaces parallel to the axis, that is, on the cylindrical part. A radial cutter is one that has teeth on the end of a cylindrical body with the cutting edges radial or nearly so. There is confusion as to the meaning of the term "face" cutter. One leading milling cutter manufacturer calls a radial cutter a face cutter, while another manufacturer applies the name face cutter to cylindrical cutters. Our preference is to use the term "face" to designate radial cutters, as it seems to be the generally accepted meaning, and, moreover, is in harmony with the meaning of the word when applied to lathe work. A "faced" surface on a turned piece is always on the end of the cylinder. —EDITOR.]

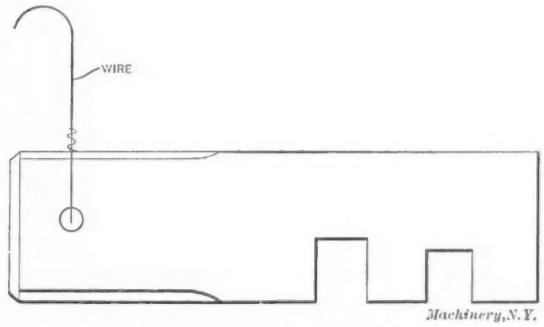
PACK-HARDENING GAGES.

E. R. MARKHAM.*

Pack-hardening, as the term is generally applied, consists in treating steel, generally tool steel, with some carbonaceous material until it will harden in oil. It is well known that steel hardened in oil is less liable to spring than when hardened in water. The tendency to crack is almost entirely done away with, unless the steel is improperly treated in the fire, and it has the maximum of toughness. Now, if we are able to treat the steel so it will be as hard as though dipped in water, and yet have the toughness due to oil hardening, and at the same time reduce the tendency to spring to the minimum, it would seem that we have the ideal method of hardening.

The experience gained during twelve years in charge of large hardening plants, where we not only did our own work, incident to a shop employing several hundred men, but also a large amount of job work from all parts of the country, together with several years spent in introducing the pack-hardening method, leads me to believe that, where it will answer the purpose, it is the ideal method of treating steel. For a number of years I have been giving advice along mechanical engineering lines, and have advised a number of manufacturers to adopt this method of hardening for certain work, and in no instance have I known of its giving anything but satisfaction. It is especially satisfactory when employed in hardening gages of various forms.

The process consists essentially in supplying the surface of the steel with an additional amount of carbon by some material that will not in any way injure the steel. In order to provide the additional carbon, the steel must be packed in



Machinery,N.Y.

Fig. 1. Piece to be Hardened, and Wire for Handling.

iron hardening boxes with the carbonizing material. Some have used charcoal for this purpose. Now, while charcoal is a carbonizing agent, and is used many times in case-hardening machinery steel, and also in the cementation process of converting wrought iron into steel, yet its effect on high-grade steel in the process of carbonizing is not satisfactory, as it renders the steel coarse, and the result similar to blister steel.

No form of bone should be used when pack-hardening tool steel, as bone contains a high percentage of phosphorus, and the effect of this is to make it weak and brittle.

For steel that does not contain more than 1¼ per cent carbon (125 points), charred leather gives the best results. Above this percentage I have for years used charred hoofs, or horns, or a mixture of the two. I formerly advocated the use of equal parts of wood charcoal and charred leather, or hoofs, or horns, as the case might be; but now I use no charcoal. The leather, hoofs, or horns, may be used over and over by adding a quantity of new material each time.

The work should be packed in the hardening boxes so no part of any piece of work comes in contact with the iron boxes; in fact, there should be at least ½ inch space between the work and the box. A layer of the carbonizing material should be placed in the bottom of the box, and a layer of work placed on this, taking care that no two pieces touch each other. If we are treating gages, or pieces of steel that are apt to spring unless care is used, we should make sure that they are so placed in the box that there will be as little liability of springing as possible when they are drawn up through the packing material. They must not be packed and

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dumped into the hardening bath, as is the case when ordinary case-hardening is done.

In order to be able to properly handle the work, each piece should be wired with a piece of *iron* binding wire, as shown in Fig. 1, and the pieces so placed in the box that there will be the least resistance possible when drawing them out. At times they may stand on edge, as shown in Fig. 1. For certain shapes, however, it is advisable to stand them on end.

When several layers of work are packed in a box, the wires should be so arranged around the edge of the box that the various layers may be taken out in order, commencing

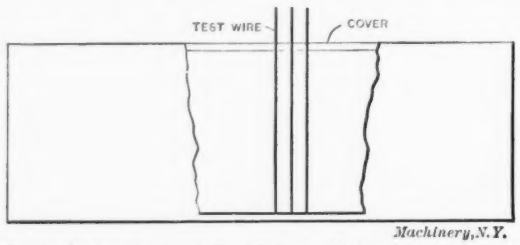


Fig. 2. Hardening Box with Test Wires which enable the Operator to determine when to begin Timing the Heat.

with the top row. This is easily accomplished by marking the sides of the box with chalk, designating the side where the top row of wires is as 1, the one where the second row is, 2, and so on. Unless we adopt some such method, the pieces get all mixed up, and some will be drawn to the surface of the packing material, and will cool before the operator has a chance to dip them.

As in all heat treatment of tool steel, the heats should be as low as is consistent with desired results, and the heats must be uniform throughout the box. It is also necessary that we gage the length of time the steel is exposed to the action of the carbonaceous material. Unsatisfactory results follow any attempt to gage the length of time by the time the boxes are in the furnace. In order that the operator may know when the contents of the box are heated, holes are drilled through the cover of the box at the center, and test wires are run down to the bottom of the box, as shown in Fig. 2. These wires should project about an inch above the top of the cover. The holes in the cover may be of any size to accommodate the wire to be used; however, I generally drill ¼-inch holes and use 3/16-inch wire. When the box has been in the fire, according to the judgment of the operator, until the contents are heated to a low red, a wire may be drawn, by means of long tongs, and its condition noted; if it is red hot, begin timing the heat; if it is not red, wait a little

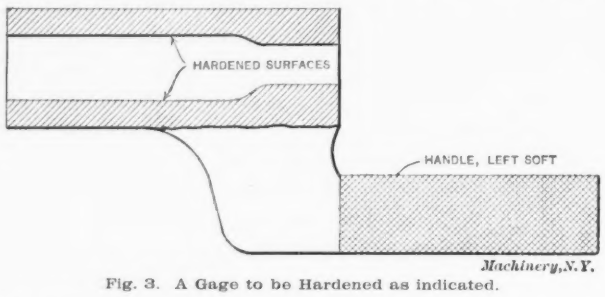


Fig. 3. A Gage to be Hardened as indicated.

while, and draw another. Continue so doing until one is drawn that is of the desired temperature. The wires passing down at the center of the box, and between the pieces, will not be red until the pieces are of the same temperature.

The length of time necessary to expose the pieces to the action of the heat depends on how deep we wish to harden the steel. For ordinary snap gages, I have found 1½ hour to 2 hours after the steel is red-hot to work well, but the time must be varied according to the percentage of carbon that the steel contains and its intended use.

Sometimes locating gages are made with the gaging holes made to finish size in the gage. This method is not to be advocated where it is possible to use hardened bushings. In the latter case, the holes in the gage may be made of the proper size for the bushings, and the gage left soft, while the bushings are hardened, ground and lapped, and pressed to place without any tendency to distort the gage. But, when it is necessary to make the gage of one piece, and have the gaging holes to size in the gage without bushings, then the pack-hardening method will be found to work satisfactorily, as the heats may be very low, and the tendency to distortion will be eliminated, provided the processes of annealing and machining have been properly done.

I recall a job of hardening gages that gave a manufacturing concern considerable trouble. The gage was of the form shown in Fig. 3, and it was necessary that the walls of the opening through the gage be hard, yet the opening must retain its shape.

The hole was filled with finely pulverized charred leather; the handle and the portion connecting it with the body were covered with fire clay which was wound with fine iron binding wire to prevent it falling away when baked. The gages were packed in scale collected in the forge shop. This scale came from the outside of pieces of iron and steel as they were being forged. Being free from carbon they absorbed, or took the carbon from the surface of the steel. I should have mentioned that the ends of the opening through the gages were covered with fire clay mixed with water to the consistency of dough, which was allowed to harden before the gages were packed. The fire clay prevented the carbon gas escaping from the leather, as the scale would have taken it up very quickly.

When the gages had been exposed to the carbonizing influence of the leather for one and one-half hour, they were removed from the box in which they were heated, placed in a bath of raw linseed oil, one at a time, and a jet of oil was pumped through the opening after the leather had been removed. The fire clay around the handle and the portion connecting it with the body was left on until the gage was hardened, when it was removed. The walls of the hole were found to be hard, and as the surface of the gage was practically decarbonized, there was little danger of its pulling the piece of steel out of shape. The handle and adjoining portion, being protected by the fire clay, did not harden, or even cool quickly enough to distort, in any way, the gaging portion.

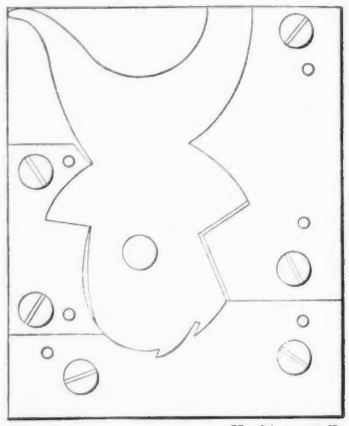


Fig. 4. Receiving Gage which is a Type Advantageously Hardened by the Pack-hardening Process.

I have known a number of instances where pieces which, while not resembling the gage shown in Fig. 3 so far as form is concerned, yet responded nicely to the method of treatment given that gage. Of course, it was necessary to modify the treatment to suit the character of the work. The gage shown in Fig. 3 was made from crucible tool steel. But, considering the small amount of wear to which it was subjected, it could have been made from a low-carbon open-hearth steel, which would have been cheaper, and could have been hardened, in the manner described, as effectively as the tool steel.

Many times receiving gages are made of several pieces which are fastened to a plate as shown in Fig. 4, which is a receiving gage for a gun hammer, and it is necessary that the various portions be gaged accurately, and each portion must bear a certain relation to every other portion.

As shown, the various portions of the gage are made in sections, fitted to place and hardened. Unless these pieces are hardened by some method that eliminates the tendency to spring, they will be of little use after they are hardened. Right here pack-hardening comes in. Pack the pieces in leather in a small iron box, run for one hour after they reach a low red heat, and harden in raw linseed or sperm oil. It will not be found necessary to heat the steel treated in this way as hot as if heated in an open fire and dipped in water. It is not necessary to heat steel in the form of gages quite as hot as if it was made into cutting tools. But, even in the latter case, be sure to keep the heats down, and do not dip in extremely cold oil; in fact, I prefer warm—not hot—oil.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

INGERSOLL COLUMN TYPE COMBINED HORIZONTAL AND VERTICAL SPINDLE MILLING MACHINE.

The column-and-knee type of machine was the first commercial form of miller. It combined the advantages of a reasonable degree of rigidity with great convenience of operation, both as related to holding the work and presenting it to the cutter, and the various adjustments, as well, could be made with the greatest ease. To give greater rigidity to the machine, (though at the cost of quickness in manipulation) there was developed later the Lincoln type of horizontal spindle milling machine—a type which is at the present time extensively used for interchangeable manufacturing and other work in which its advantages are most in demand, and its deficiencies of least moment. Of recent years, the column-and-knee type of machine has been given a rigidity very closely approximating that of the less convenient Lincoln miller, by the use of suitable knee supports, braces, etc.

With the continued use of these machines, it was found that there were many operations which it was inconvenient to perform with the horizontal spindle. For instance, it was soon discovered that the largest quantity of metal could be removed in a given time with the least power, if a cutter of the face mill variety were used in place of the original cylindrical cutter. With comparatively thin work having large areas to be finished with face cutters, a horizontal table and horizontal spindle required that the work be held on a clumsy knee support of some kind. This arrangement was obviously a makeshift, so the vertical attachment to the horizontal miller was designed, and applied to the work of face milling. Though particularly adapted to the use of face and end mills, it soon proved a useful attachment in various ways, being applied to the form and circular milling, and accurate drilling and boring. It was thus possible to finish many parts complete at one setting, that would otherwise have to be reset several times. Owing to the usefulness of the vertical attachment, machine tool builders soon began to build millers in which the frame and driving mechanism were especially designed for the vertical spindle, instead of having it used as an attachment. The vertical spindle milling machine now ranks among the most important of machine tools, and has been extensively applied to the wide range of work to which it is adapted.

There has still been found a field, however, for the horizontal machine with vertical attachment; for one thing, there is the advantage of obtaining a machine capable of performing in a very satisfactory way a wide range of milling at a considerably less capital expenditure than would be required for the two machines otherwise necessary. Besides this it offers the advantage, oftentimes an important one, of being able to finish work complete without removing the part from the machine, since the machine may be changed to use either the horizontal or vertical spindle, as well. For this reason, the horizontal machine with vertical attachment is an exceedingly useful and popular combination. This being the case, it would naturally seem that there might be a field for a milling machine combining the vertical and horizontal spindle mechanisms in permanent form, without the sacrifice of rigidity and consequent producing power which comes from having one of these spindles in the form of an attachment. Such a machine might easily be made, as well, so that on some work both horizontal and vertical spindles could be used simultaneously, thus effecting a material saving in time and cost of work produced. If such a machine is provided with the necessary supports and braces so as to give it a large measure of the ruggedness of the Lincoln type of machine (or its larger counterpart, the planer type miller) the resulting tool should find a wide field waiting for it in the machine-building industry. Such a machine has been designed and is being built by the Ingersoll Milling Machine Co., of Rockford, Ill. It is illustrated in Figs. 1 to 4, shown herewith, and is described in the following paragraphs.

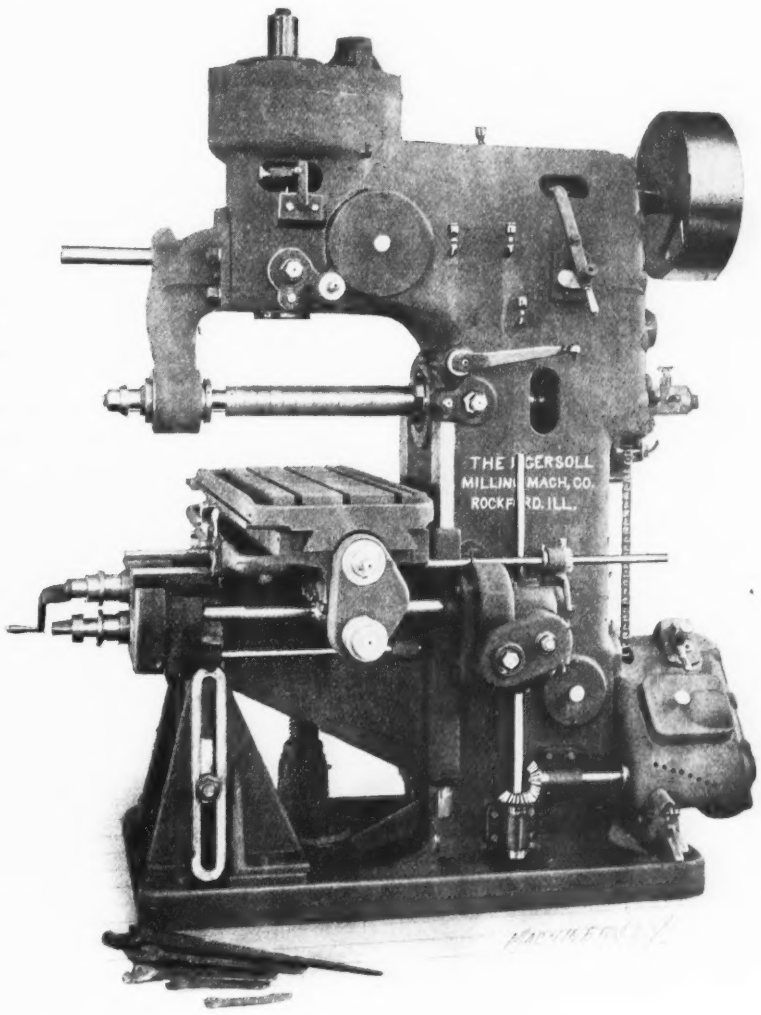


Fig. 1. Ingersoll Combined Vertical and Horizontal Miller.

General Arrangement of the Machine.

As may be seen in Fig. 1, all of the machine below the horizontal spindle is very similar in appearance to the ordinary type of column-and-knee milling machine, though it will be seen that it is unusually rugged for a tool of this kind. Above the spindle, the column of the machine is brought forward to furnish a housing for the vertical spindle, which, owing to the stiff support thus given it, can be carried well out from the face of the column, allowing a considerable range of cross feed. For the same reason, the knee is unusually long, and is therefore well supported at the outer end to give the required stiffness for heavy work and heavy cuts.

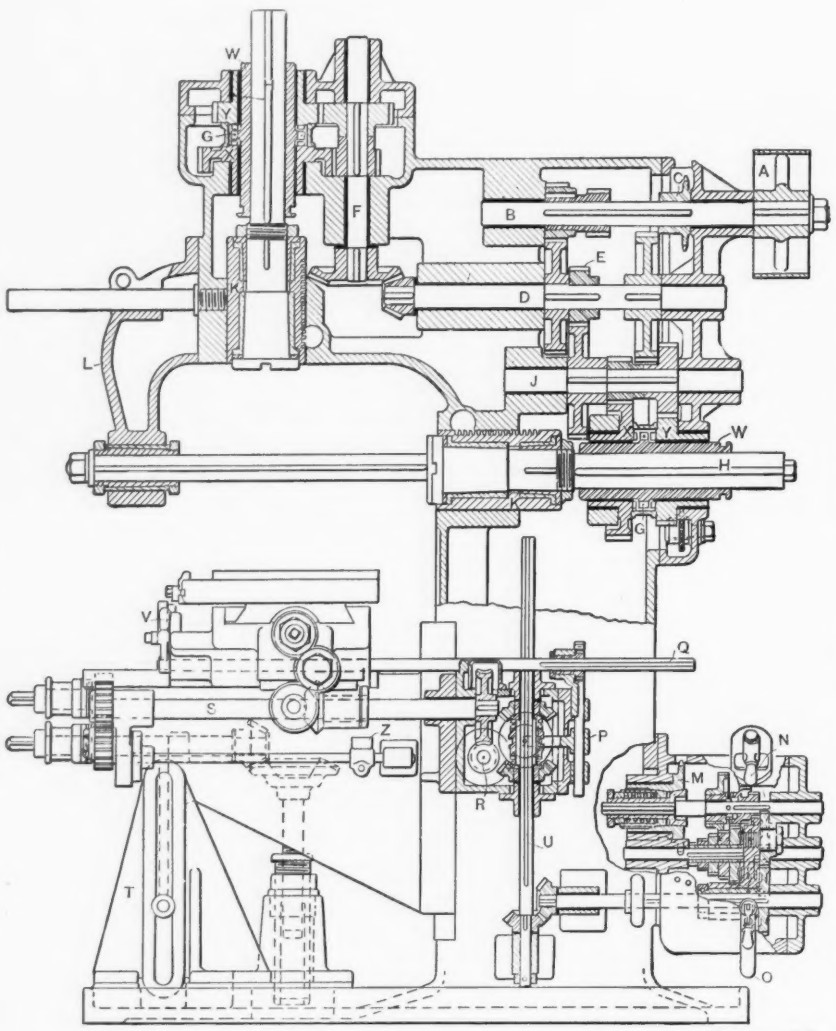
In accordance with approved milling machine practice of the present day, the whole machine is driven from a single diameter pulley, and the speed changes are obtained by the operation of positive acting, quick-change mechanisms involving the use of clutches and gearing. As is also required by the best practice, the feeding movement is taken directly from the driving shaft, and the feed changes are made by a positive quick-change gear mechanism. Longitudinal, cross, and vertical power feeds are provided, all of them reversible, and all provided with automatic stops. The out-board support

necessary for the arbor in heavy horizontal milling has not been forgotten, and the usual brace for connecting the knee with this support is furnished, though it is not shown in place in any of the illustrations. The machine will thus be seen to be designed along the lines of the best practice for both the horizontal and vertical types, which it combines within itself.

The Spindle Driving Mechanism.

The mechanism of this milling machine will best be understood by reference to Fig. 2. The power is applied to driving pulley *A*, which is keyed to shaft *B*. This shaft carries sprocket *C* which drives the feed, as will be explained later, and the double pinions shown, which may be shifted to engage either one of the corresponding gears on shaft *D* below them. The shifting of these gears is effected by the handle shown entering the slot in the upper left-hand corner of the column in Fig. 1. Two changes of speed are obtained with this level. Shaft *D* is connected by bevel gearing with the vertical shaft *F*, from which motion is transmitted to the vertical spindle. Pinion *E* on shaft *D* meshes with a gear on shaft *J*, from which motion is transmitted to the horizontal spindle. These two spindles are alike in their dimensions and in their driving mechanism, so the same reference letters apply to each. Each is supported at the back or upper end in a sleeve *W*, which is keyed to it, and which is provided with clutch teeth *G*. These teeth are adapted to engage corresponding clutch teeth on the hubs of gears *X* and *Y*, which revolve loosely on *W* and in their bearings in the frame. *X* and *Y* are driven by corresponding pinions on shaft *J* for the horizontal spindle, and on shaft *F* for the vertical spindle. It will thus be seen that by the shifting of sleeves *W*, either of two speeds may be given to either of the two spindles or, by putting the teeth *G* in the central position, either spindle may be stopped. Sleeve *W* for each spindle is shifted by the hand levers shown in Fig. 1; one at the back of the column in line with the horizontal spindle, and the other projecting from an opening in the vertical spindle housing. Gear *X* is 13 inches pitch diameter, with four diametral pitch teeth; the smaller one has the same pitch of teeth and is 10¼ inches in diameter. Both have 2½-inch faces, giving a very powerful drive.

Four spindle speeds for each of the vertical and horizontal spindles are thus provided for, with driving pulley *A* running at constant speed. In practice, with belt-driven machines, a two-speed counter-shaft would be used, giving eight speeds in all, ranging from 15 to 100 revolutions per minute. The machine is well adapted for a motor drive, in which case the motor is mounted on top of the column and connected to shaft *B* by means of a silent chain and sprocket wheels. A 10 H. P. motor is used, having a 2 to 1 speed variation, ranging from about 500 to 1,000 revolutions per minute. This would give the same range of spindle speeds as for the belt driven machine, the number of changes being dependent upon the number of steps in the controller.



Machinery, N.Y.

Fig. 2. Vertical Section through the Machine showing Driving and Feed Mechanism.

The front bearing of each spindle is contained in a sleeve *K*, which may be adjusted axially by means of rack teeth cut in it, engaging the teeth of a pinion on a short shaft which projects through the side of the column, and is provided with a squared end for engagement with a hand crank. The axial positions of the two spindles with relation to each other may thus be adjusted to suit the work in hand. This is especially necessary in cases such as shown in Fig. 4, in which both spindles are used simultaneously. The front spindle bearing consists of two tapered journals, one of them being formed on a sleeve adjustable endwise to take up wear. These journals run in phosphor-bronze boxes, supported in the sleeves *K*. The spindles are of hammered crucible steel, 4½ inches diameter in the front bearing. The sleeves or quills *K* are 12 inches long and have 6 inches of adjustment read from graduated scales.

The Feed Mechanism.

As previously mentioned, the feed is driven from sprocket wheel *C* on driving shaft *B*. This is in accordance with approved practice, which makes (so far as possible) the feeds independent of the spindle speed changes. They are nearly independent in this case, being affected only by the 2 to 1 variation of driving pulley *A*, given by the two-speed counter-shaft or by the variable speed motor. The chain from sprocket *C* drives sprocket *M* in the gear box shown at the rear of the base of the machine in Figs. 1 and 2. This gear box contains a quick-change-gear mechanism of the well-known type first introduced in the Hendey-Norton lathe. Eight changes are provided for by the shifting of handle *O*, which controls the sliding tumbler gear, and this number is doubled, giving 16 in all, by handle *N*, which operates a shifting pinion and clutch so as to drive the cone of gears at either of two speeds. The 16 feeds thus given range from 0.48 to 8.9 inches per minute, with the slow speed of counter-shaft or motor; at the fastest speed the feed ranges from 0.97 to 17.8 inches per minute. These rates of feed can be doubled, as described later.

To provide a safety mechanism to prevent damage to the machine in case something should prevent the operation of the feed, and also to permit the feed change mechanism to be operated while the machine is in motion without inducing dangerous shock, sprocket wheel *M* is not directly keyed to the shaft which it drives. Instead of this, its bore is finished with a double taper in which are supported two taper cones, pressed together by the spring shown. One of these cones has a long hub, which is keyed to the shaft. The compression of the spring thus forces the cones together, and furnishes an adjustable frictional driving device between the

sprocket and the shaft, which is sufficient for the heaviest feeds required on the machine, but will yet give way in case of undue strain.

The gear box is connected by a horizontal shaft and bevel gears to the splined vertical shaft *U*. The latter passes through a gear casing attached to the knee, and containing a clutch-and-bevel-gear reversing mechanism of conventional type, operated by clutch fork *P*. The central bevel gear of this mechanism is connected by spur gears with worm *R*, which drives the worm-wheel keyed to horizontal splined shaft *S* from which are derived the various feed movements. The spur gears connecting worm *R* with the bevel gear can be taken off and reversed, being contained in the removable guard shown attached to the front of the casing in Fig. 1. By this means the feeds given in the preceding paragraph can be doubled.

The gearing, shown at the end of the table, connects splined shaft *S* with the table feed-screw for the longitudinal movement. The usual slot is provided at the front edge of the table for the adjustable dog which operates the automatic feed stop. This strikes a tappet connected with lever *V*, which is attached to rock shaft *Q*. The latter extending to the casing containing the reversing mechanism, is splined to a pinion which operates the vertical rack to which the reversing clutch fork *P* is attached. By this means, the dog on the front of the table may be set to automatically stop the feed of the table in either direction. Handle *V* is also conveniently used for reversing the feeds. Connections at the front of the table provide for operating both the cross and vertical feeds by power. The cross feed has the same

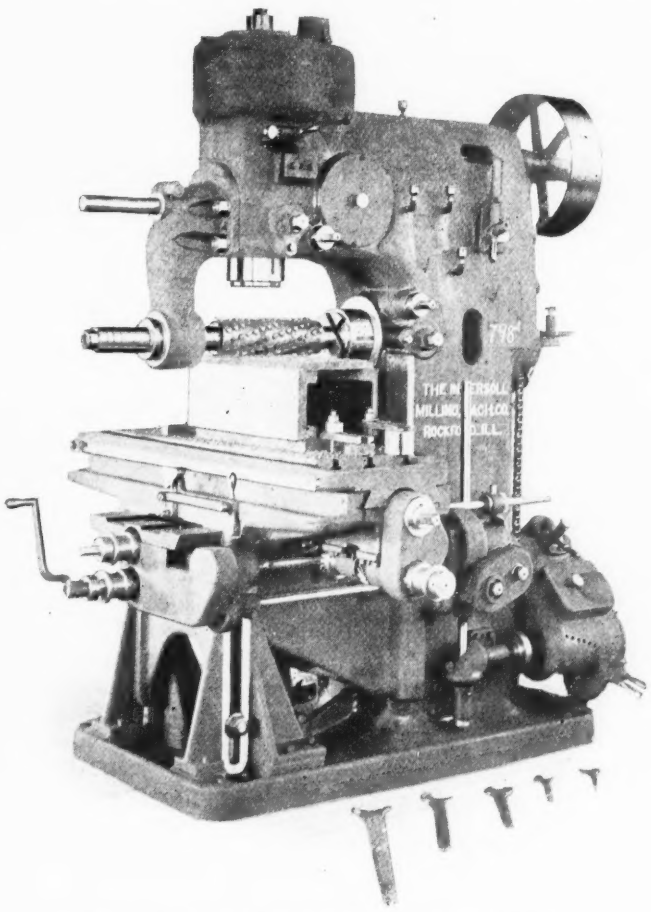


Fig. 3. Using the Machine as a Plain Horizontal Miller.

rate of movement as the longitudinal feed, while the rate of the vertical feed is half that of the other two. Stops are provided for the cross and vertical movements, that for the former being shown at *Z*.

Dimensions and Capacity.

The table is 60 inches long with 48 inches of working length; the full width is 19 inches and the working width 18 inches. It is 5 inches thick, and is provided with three slots cut from the solid, and with drilled holes for stops for the work. The saddle is 60 inches long and 6 inches deep, giving a full support to the table even at the extremes of its travel. The knee is 36 inches long and has a bearing of 28 inches on the column, besides being supported by the heavy outboard support *T*, previously mentioned. The longitudinal feed is 56 inches, the cross feed 16 inches, and the vertical feed 18 inches. As mentioned, the spindles have each a longitudinal adjustment of 6 inches. The maximum distance between the center of the table and the column is 24 inches; the least, 8 inches. The maximum distance from the top of the table to the face of the vertical spindle is 26 inches; the minimum distance with the sleeve extended is 2 inches. The maximum

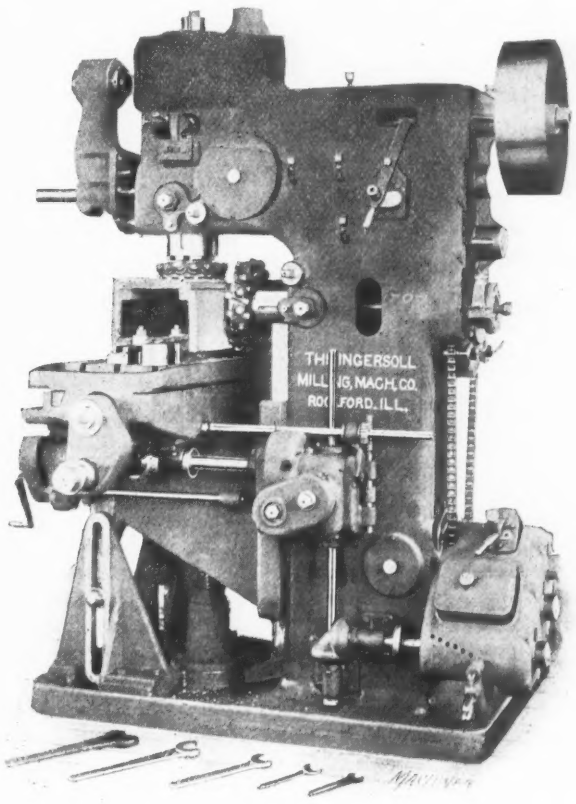


Fig. 4. Using the Horizontal and Vertical Spindles simultaneously in a Face Milling Operation.

distance from the center of the horizontal spindle to the top of the table is 16 inches, and the minimum, zero. A circular table 16 inches in diameter with automatic feed and automatic stop can be furnished if required, at an additional cost. The weight of the machine complete without this table is 9,700 pounds.

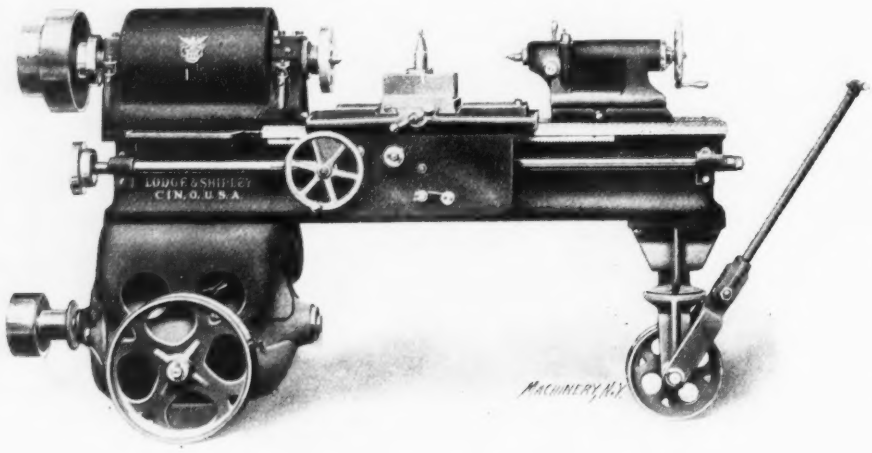
The Operation of the Machine.

In Figs 3 and 4 are two views of the machine in operation. In the first case it is shown with a job of plain slab milling, with the vertical attachment out of commission; as will be seen, the outer end of the cutter arbor is supported by the over-hanging arm (*L* in Fig. 2), so the machine has all the possibilities in the way of accuracy and rate of output found in machines of the strictly horizontal type. In Fig. 4 both spindles are shown in use operating face mills for surfacing the top and side of a hollow rectangular casting. In this case, the outboard support has been loosened and turned up out of the way, being for that purpose swiveled about the stud which carries it. In such cases as this, it will be seen that the output is equal to that of the horizontal and vertical machines combined. As a vertical machine, it should evidently have a greater capacity than the horizontal machine with vertical attachment, and be fully equal to that of the standard vertical machine of the same capacity. The tool has, in fact, been designed by its makers as a general utility machine, able to take the heaviest cuts, either horizontal or vertical, without harmful vibration or other sign of distress.

LODGE & SHIPLEY PORTABLE LATHE.

The lathe shown herewith has been designed by its builder, the Lodge & Shipley Machine Tool Co. of Cincinnati, Ohio, for use in locomotive repair shops for such work as fitting frame bolts, turning up studs, etc., and for doing the various miscel-

laneous fitting work which is met with in assembling heavy machinery. In a word, it will be found convenient for assembling work on any form of machinery so large that it is inconvenient or impossible to move to the lathe the parts into which the work is to be fitted. Bringing the machine to the work, as is made possible by this design, is a much more convenient and economical proceeding.



Portable Lodge & Shipley Lathe for Fitting Work on Heavy Machinery.

As may be seen in the engraving, the lathe is mounted on three wheels so that it is always properly supported, no matter how uneven the floor on which it is placed. The leading truck at the tail-stock end of the bed swivels, and is provided with a handle by which the lathe is drawn from place to place. The "leg" under the head-stock end of the bed is mounted on two wheels, and is arranged to support the motor by which the tool is driven. This motor is of 2½ horse-power and of the constant speed type, fully enclosed. Its armature shaft carries a 2-step cone pulley, belted to a corresponding pulley on the back gear shaft. As the range of work for which the lathe is required is limited, but two speed changes have been provided, resulting in a driving mechanism of great simplicity. The lathe is supplied with a belt feed of two changes, power longitudinal feed, and plain rest. When desired, it can also be supplied with a taper attachment. Nothing which is not required for the simple work it has to perform has been retained in the design of the machine. As constructed, it will do the work for which it is required with great rapidity. If desired by the purchaser, the same tool will be furnished with legs instead of wheels.

THE LE BLOND UNIVERSAL CUTTER AND TOOL GRINDER.

Being convinced, as milling machine manufacturers and users, that sharp cutters are a prime requirement for rapid and economical milling, the R. K. Le Blond Machine Tool Co., 4605 Eastern Ave., Cincinnati, Ohio, has designed and placed on the market a universal cutter and tool grinder. There are a great many machines of this kind made, and perhaps no tool is so far from being standardized in design, each make differing radically in construction from any other with which it may be compared. This new machine likewise differs from others hitherto built, presenting a number of distinctly original ideas in design and construction. These ideas are so strikingly practical and serviceable, however, that the machine is worthy of detailed study. We are permitted to present herewith enough of illustrative and descriptive matter to give a comprehensive idea of the design of the machine.

General Description.

The tool follows in its outlines the general plan of the universal milling machine, with such additional adjustments and movements as are required for the work of a cutter and reamer grinder. As may be seen in Fig. 1, which gives a front view of the machine, the framework consists of a cabinet base, on which is mounted a column surmounted by the grinding spindle head, which is clamped permanently in place. Around this column, marked *A* in Fig. 2, is placed a split sleeve *B*, which may be clamped in any angular position around the vertical axis by handles *C*. The front of this sleeve is provided with ways on which slides the box-shaped knee *D*. A saddle *E*, which may be adjusted towards or away from the column along the top of this knee, is provided with longitudinal ways for the table guide *F*, to which is swiveled, about pivot *G*, the work table *H*. It will be seen that this arrangement differs from that of the universal milling machine only in having the work table swivel on the guide *F*, instead of having the latter swivel on the saddle.

The construction followed is a rigid and durable one, and has been purposely adopted in place of the lighter skeleton design employed in other machines for the same purpose. It will be noted in Figs. 1 and 2 that the sides of the saddle are brought down over its bearing on the knee, and that the ends of table guide *F* project beyond the bearing on the saddle at the extreme limit of the travel in either direction, so that these bearings are well protected from the emery and the grit which always surrounds a machine of this kind. Felt strips are provided for cleaning and oiling the surfaces of the table and saddle bearings as well as the vertical ways on the knee. By this means the continued usefulness of the machine is assured for a long period of years.

The purposes of the various adjustments provided will be better understood when reference is made later on to the different operations for which the tool is adapted.

Details of Construction.

The wheel spindle *J* has taper boxes as shown in Fig. 2, and is driven by a single pulley for a 2-inch belt. The cone on the

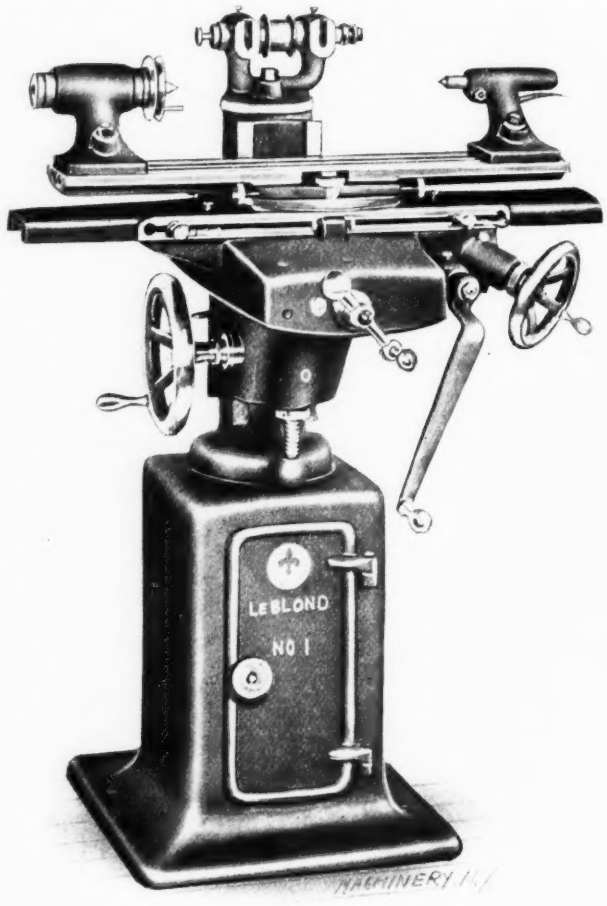


Fig. 1. The Universal Cutter and Tool Grinder built by the R. K. Le Blond Machine Tool Co.

counter-shaft gives three spindle speeds, which should be proportioned to give 3,175, 4,200, and 6,365 R.P.M., respectively. In the engraving, the left-hand end is adapted to the holding of wheels directly on the spindle, between the collars, while a tapered hole for a correspondingly tapered arbor *P*, is pro-

vided at the other end of the spindle. A variety of these arbors may be used with the wheels permanently mounted on them. When this plan is followed the wheels may be removed and replaced without it being necessary to true them up each time. Dust-proof collars are provided, and the oil holes have dust-proof covers, the same protection being afforded all provisions for lubrication throughout the machine.

The head-stock spindle, which is tapering, revolves in a removable sleeve, which can be clamped in the V-block of the universal attachment, described later. The front end is threaded to receive a chuck. The foot-stock has a spring center actuated by a thumb lever. This center can be removed and a special center inserted for grinding reamers. The table is provided with two T-slots, one of them set on an angle, as shown in Fig. 2, for drawing the head- and foot-stock down and forward against the left-hand side of the slot, to insure parallelism; the other at the right provides for the clamping of the various fixtures, vises, etc., that may be used on the machine.

Movements and Adjustments.

The table *H*, as has been explained, swivels on table guide *F* about stud *G*, which is a drive fit in *F*. The angular movement possible extends through an arc of 90 degrees on either side of the central position, the setting being read from the

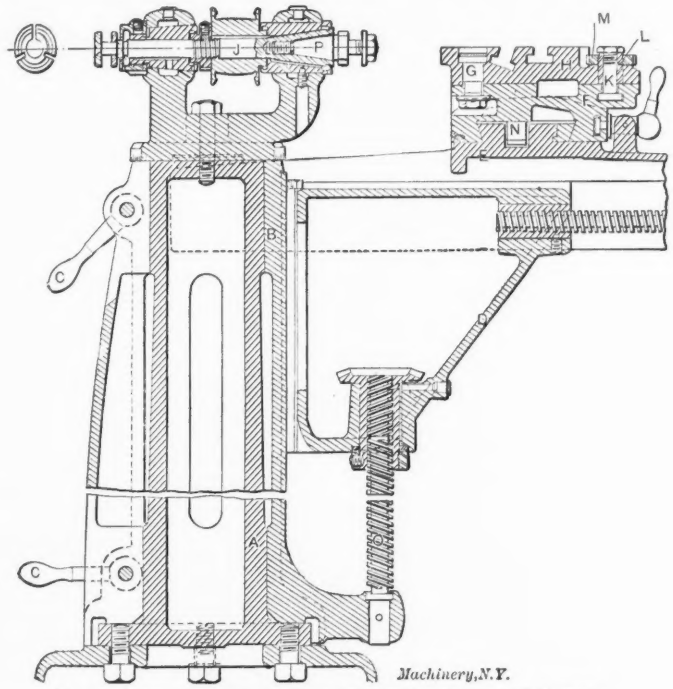


Fig. 2. Vertical Section through the Table, Knee, and Column, showing the General Construction.

graduated surface shown in the engravings. Provision is made for both rapid and fine angular adjustment of the table. The bolt *K*, by which it is clamped, passes through a threaded sleeve *L*. If the slotted nut *M* which is threaded on this sleeve is raised from contact with the boss on the table, the tightening down of the nut on bolt *K* tightens *L* down on *F*, but leaves the table free to be adjusted through the small range permitted by the slot in which *L* is located. Projecting into this slot are two screws with milled heads, seen in Fig. 1 and other following figures. By adjusting these, the angular position of the table on the table guide may be set very finely to the desired position. When this setting has been obtained, the screwing down of the slotted nut *M* clamps the table in position.

Table guide *F* receives its longitudinal movement on the saddle from a shaft carrying a gear meshing with rack *N*. This shaft passes through the saddle, projecting both at the front and the rear. On either end of it may be mounted a handle for the rapid operation of the table movement. This handle is shown mounted at the front of the machine in Fig. 1 and on the back in Fig. 3. On this same shaft is keyed a spiral gear, meshing with a spiral pinion on the shaft of the hand-wheel seen projecting obliquely downward at the right of the saddle in Fig. 1. By means of this the table may be given a fine angular adjustment. As may be seen at the left of Fig. 5, this hand-wheel and its shaft are mounted in an eccentric sleeve, which may be rotated by the handle shown in back of the hand-wheel, to throw the spiral pinion out of mesh with the gear, leaving the shaft free for the rapid movement by means of the handles described, when this rapid movement is desired. A projecting boss on the top of the saddle is provided with adjusting screws, which act as abutments for adjustable stops in the T-slot in front of the table guide, as shown in Figs. 1 and 2. These stops limit the longitudinal travel of the table.

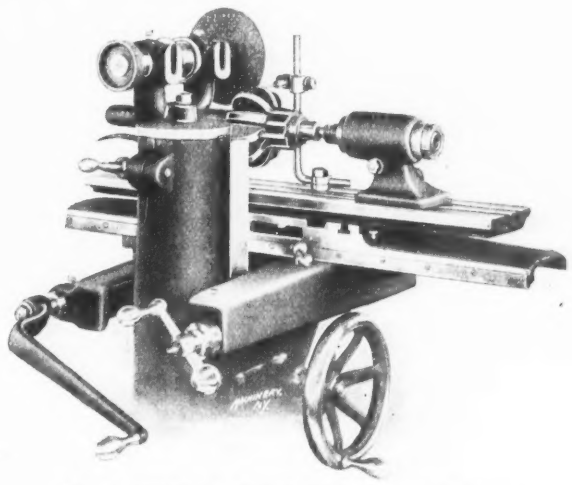


Fig. 3. Grinding a Formed Cutter between Centers.

The cross-feed screw is geared with a shaft which passes through to the back of the saddle, so that the movement of the saddle on the knee may be effected through the crank shown at the front of the saddle in Fig. 1, or by that shown at the rear in Figs. 3, 4, 5, etc. This provision for operating either the longitudinal or the cross movements from the rear of the machine is a feature which makes it possible for the operator to work always at the best advantage, so far as the close observation of his work is concerned. It is not necessary for him to take a position which may be convenient for the operation of the hand-wheels, etc., but inconvenient for watching the progress of his work.

The raising and lowering of the knee on the table is effected by screw *O*, which is connected by bevel gears with the hand-wheel shown at the side of the knee. Graduated dials are provided, reading to thousandths, for the cross and vertical

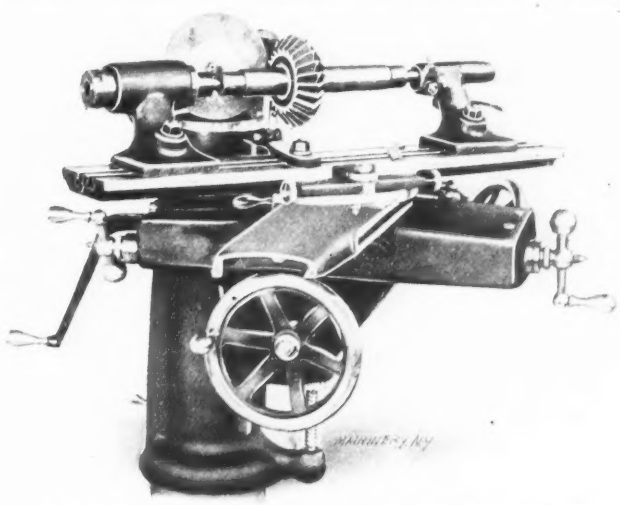


Fig. 4. Table set with Fine Adjustment for Grinding 45-degree Angle Cutters.

movements. All of the various adjustments with the exception of the swiveling and clamping of table *H* on table guide *F*, are effected by fixed handles so that the use of a separate wrench is largely avoided. The range of movement provided throughout the machine is such that large saws and face mills can be ground, as well as the smaller work on formed cutters, hobs, reamers, etc.

Grinding Cutters on Centers.

The half-tone reproductions of photographs in Figs. 3 to 8, inclusive, show a sufficient number of the various applica-

tions of the machine to give a good idea of the range of work to which it is adapted. In Fig. 3 it is shown set up for grinding a formed cutter, which is mounted on an arbor between centers, while the radial faces of its teeth are ground. The back of the tooth being ground rests against the stop shown, clamped in the front T-slot of the table. For this work, the operator would stand in the foreground of the picture, with the machine arranged as shown, the operating handle being attached to the back end of the table feed-shaft. The workman can thus easily see the face of the tooth which is being ground—a condition which is not always possible in other machines of this kind.

In Fig. 4 is shown the grinding of an angular mill, also mounted on an arbor between centers, as in the previous case. For this operation, however, the table has to be swiveled on the table guide to the angle of the cutting edge being ground. A disk wheel is used in this case, instead of the dished wheel of Fig. 3, so that the tooth has to be supported from the under side, necessitating the use of a different form of tooth rest. As before, the operator works the table feed from the handle

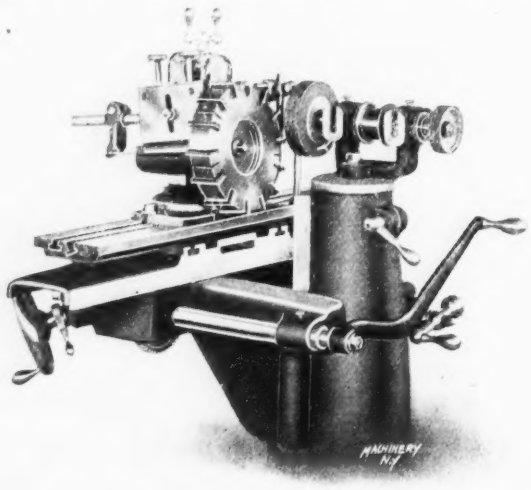


Fig. 5. Grinding Face Mill—Taper Shank held in Universal Attachment.

at the rear of the machine, this being the most convenient position for observing the progress of the work. The table stops are set to limit the movement of the table in one direction, to prevent the wheel from running into the arbor, and in the other direction to allow it to clear the cutter just enough to permit indexing for the next tooth.

The Universal Attachment and its Applications.

In Figs. 5, 6, and 7 is shown the universal head provided with the machine, engaged in holding, for presentation to the grinding wheels, cutting tools of various kinds. Detailed

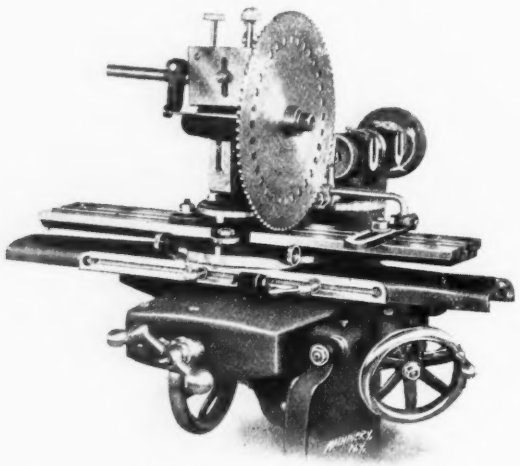


Fig. 6. Grinding a 16-inch Saw held in Universal Attachment.

drawings of this head are shown in Fig. 9. It consists of a base Q, to which is clamped the standard R, which may be fastened at any angle about the vertical axis, by means of the bolts shown, the adjustment being read from the graduations on the standard. This column is provided with ways to which is gibbed slide S, which may be adjusted vertically by means of screw T and the attached double crank. Clamped to S, and adjustable on it to any angle about the horizontal axis, is V-block U, the periphery of whose base is also provided

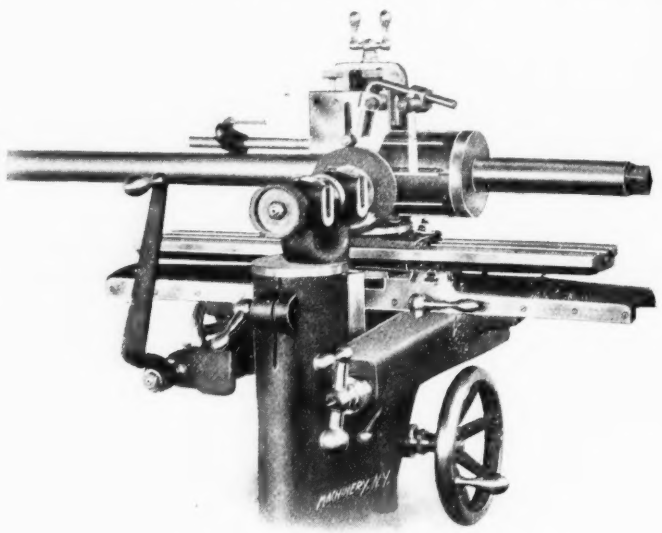


Fig. 7. Sharpening a 5 1-2-inch Shell Reamer without removing it from Arbor.

with graduations by means of which the angular adjustment may be read. Plate X, operated by two adjusting screws W, whose collars enter slots cut in X, is used for holding the work against the V-groove in U. A center stop Y mounted in the holder clamped to adjustable bar Z is used for locating the work as will be described.

The various adjustments provided for this attachment make it of almost universal application. Three of these applications are shown in Figs. 5, 6, and 7. In the first case, we have

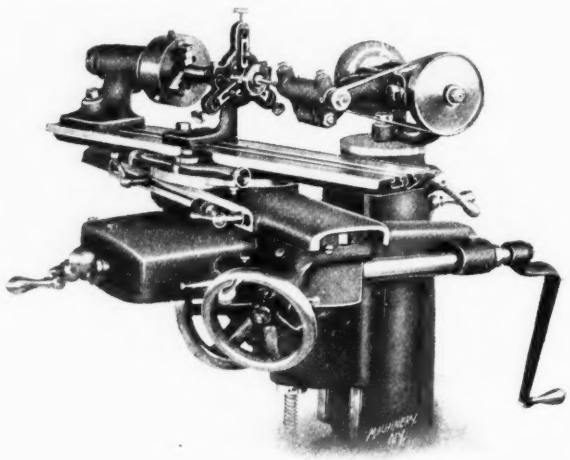


Fig. 8. Grinding a Taper Hole in Spindle, with Internal Attachment.

a face mill being ground on its own taper shank. The shank is inserted in the V-groove of U, and is brought back against the ball point of center Y, which is adjusted for that purpose to the proper position. Then plate X is screwed down to bear lightly on the shank of the cutter by turning handles W, being clamped in this position by the nut and stud provided for that purpose. The tooth rest previously shown is arranged to support the cutter properly for grinding. The whole block U is swiveled on S about a horizontal axis to give the clearance desired. In this case, also, the table is operated with the handle at the back side of the knee.

In Fig. 6 a saw blade of the Higley type is being ground in the taper attachment, which is set in the same way as for the previous case, except that the axis of the taper shank is set in a horizontal position. A cup wheel is being used in this case also. Since it is most convenient to watch this operation from the front of the machine, the table feed handle is placed in front as shown.

In Fig. 7 an inserted tooth reamer is being ground on the long bar on which it is carried, without removing it from the latter. The bar is inserted in the universal head in the

way previously described, and the tooth rest is mounted on the face of the clamping plate of the device as shown. A comparison of Figs. 3, 4, 5, 6, and 7 serves very well to illustrate the adaptability of the form of tooth rest provided.

Cylindrical and Taper Surface Grinding.

Complete provision is made for cylindrical taper and surface grinding in the design of the machine. An example of taper grinding is shown in Fig. 8. The work is secured in a chuck, mounted on the head-stock spindle, while its outer end revolves between the jaws of the back-rest, which is a part

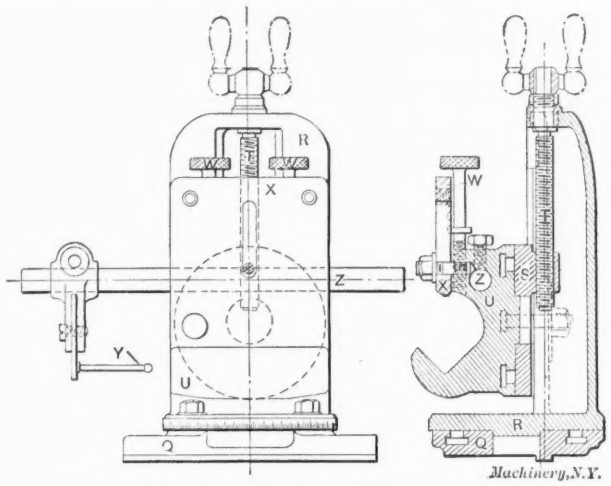


Fig. 9. Details of Construction of Universal Attachment.

of the equipment of the machine. The internal attachment is clamped to the face of the grinding head. It carries a spindle adjustable, as shown, to maintain the tension of the driving belt, which is driven by a pulley mounted on the main spindle in place of the usual grinding wheel. The taper of the table is adjusted on the table guide to the angle required for the taper of the hole being ground. The head-stock spindle is driven by a belt from the drum in the over-head works, which is connected with the main counter-shaft by a 3-cone pulley, giving suitable rates of speed for various diameters of work.

For angular work which may be held in a chuck, the head-stock spindle may be removed from the head-stock and clamped in the universal attachment shown in Figs. 5, 6, 7, and 9. The spindle may then be set to any angle for either external or internal grinding, being driven from the over-head drum as before. For surface grinding, the work may be strapped to the table or a magnetic chuck may be used, or the work, if small, may be held in the adjustable swivel vise which is part of the equipment of the machine.

Gear-cutter Grinding and Other Attachments.

Besides the universal attachment, tooth rests, back rest, internal attachment, and vise, previously described, a number of other conveniences are provided. Among them is a device for grinding, radially, gear-cutters and other narrow formed cutters. This device is shown in Fig. 10. It consists, as may be seen, of a plate bolted to the work table, carrying a swinging gage and two studs, on one of which is mounted the cutter to be ground, while the other carries an adjustable tooth rest. After placing the cutter on the stud (using a reducing bushing if necessary) the swinging gage is brought over until it enters the tooth space, and the tooth rest is brought up until the face of the tooth is forced against this gage. The face of the tooth is then radial, and the slight amount taken off in the sharpening does not perceptibly alter its radial accuracy.

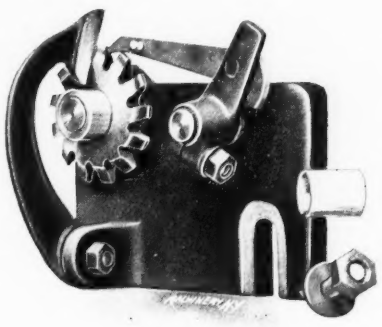


Fig. 10. Device for Grinding Gear-cutters radially.

There are included in the equipment, besides the parts mentioned, dogs for revolving work to be ground on centers, gages for centering the spindle with the work, the requisite wrenches, etc., and a counter-shaft with the necessary tight and loose pulleys, cones, etc., for driving the grinding wheel and work spindles at their proper speeds.

Dimensions and Capacity.

The machine will take 18 inches between the centers, and will swing 8 inches. The working surface of the table is 5½ x 29 inches, and it has a longitudinal movement of 17 inches. The cross movement is 6¼ inches, and the vertical adjustment 8¼ inches. The machine, as will be appreciated from the previous description, will grind any face of any ordinary shape of cutter, to any angle. It is adapted as well to grinding all kinds of cylindrical and angular work, face mills, end mills, reamers, counterbores, gear-cutters, rose reamers, flat surfaces, punches, dies and other kinds of work. It has been in operation in the shop of the builders for nearly two years, where it has undergone a thorough trying-out on all kinds of operations. During this period, weak points in the design have been eliminated, and many improvements have been made. The builders are now placing it on the market with full confidence in its capacity for doing unusually rapid and accurate work.

FARWELL AUTOMATIC SPUR GEAR HOBBING MACHINE.

The spur gear hobbing process is inherently a very simple operation, as has been brought out in the description of the subject in a previous issue of MACHINERY (see "Gear-Cutting Machinery" in the March, 1908, issue, engineering edition). In most commercial gear-cutting machines of this type, however, the complication required to make them universal in their application has so elaborated the mechanism that the machine is as complex as the orthodox spur gear cutter with its slow feed and quick return, and its automatic indexing mechanism. In Fig. 1 is shown a gear-hobbing machine made by the Adams Co. of Dubuque, Iowa, in which the movements and adjustments have been reduced to a minimum, so that the basic simplicity of the process is fairly shown. The fact that it is not designed for the hobbing of spiral gears, and that it is intended to be fed by hand when hobbing worm wheels, in addition to the particular pains taken to avoid complication, have all resulted in making a strong, simple and inexpensive tool.

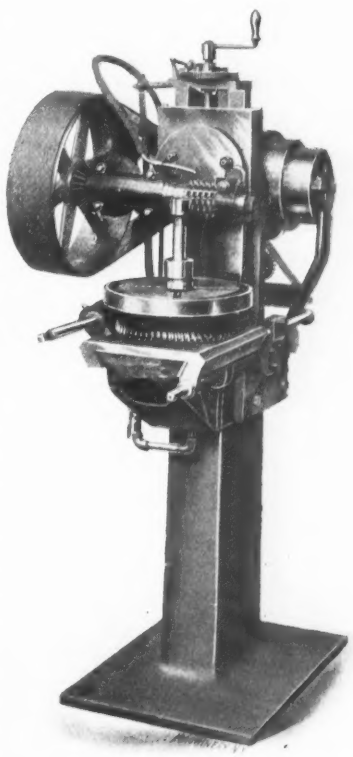


Fig. 1. Simple Spur Gear Hobbing Machine made by the Adams Co., Dubuque, Iowa.

A machine of this type must provide means for driving a hob or cutter spindle, which is mounted on a head which may be swiveled to the helix angle of the hob. This hob or cutter must be connected by change gearing with the work spindle or face-plate, so that the two may be rotated together in the ratio of the number of teeth in the gear to the number of threads in the hob. An automatic feed has to be provided for forcing the hob down through the work. These movements are readily followed in Figs. 1, 2 and 3. As will be seen, the frame of the machine is a stout column, provided with a knee along which the work table is adjusted for the diameter of

the blank. The outer face of the column is provided with ways on which the cutter slide is fed. The machine is driven from a cone pulley at the rear, mounted on a counter-shaft supported in a swinging frame; the cutter spindle is driven by a large pulley, belted directly to this counter-shaft. The counter-slide and counter-shaft frame are connected by an adjustable link, so that the proper belt tension is maintained whatever the position of the cutter slide on the column. As before explained, the spindle is mounted on a swiveled head

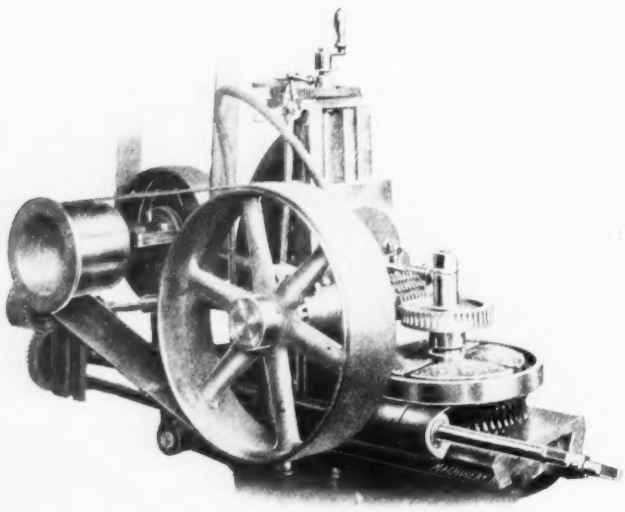


Fig. 2. Side View showing Driving Mechanism and Change Gear Connections.

on the cutter slide, so that it may be adjusted to the helix angle of the hob. The slight angular adjustment required for this is not sufficient to disturb the proper action of the belt which drives the spindle.

The cutter spindle has keyed to it, next to the hub of the driving pulley, a bevel gear meshing with a corresponding gear driving a telescopic shaft which extends toward the rear of the machine. This is best seen in Figs. 2 and 3. At the further end, this telescopic shaft drives one of a pair of change gears, of which the other is connected to the shaft on which is mounted the worm driving the work table worm-wheel. This furnishes the positive connection required between the hob and the work. The change gears are selected to suit the ratio between the number of teeth in the gear and the number of threads (one if single thread, two if double

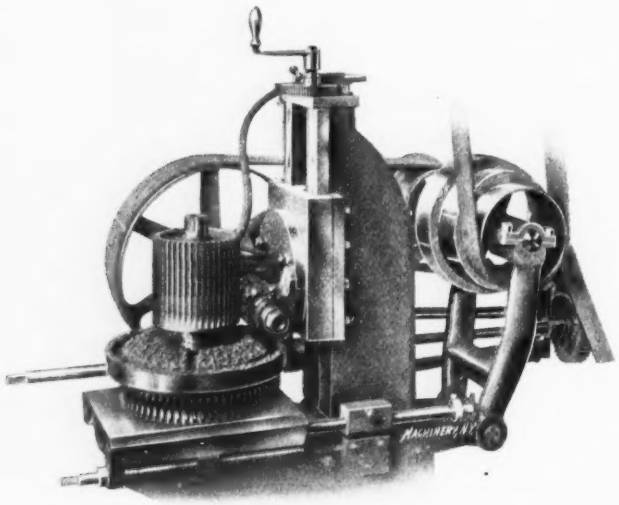


Fig. 3. View from the Right Side showing Stop Screw for Depth of Cut.

thread, etc.) in the hob. The table revolves upon a wide angle surface, which gives it great rigidity. This, in connection with the small number of joints, and the large size of the gears and shafts connecting the work table and the spindle, insures a very steady, positive drive for the former. This is essential for accurate work.

The feed of the cutter slide on the head is effected by a ratchet movement, operated from an eccentric on the table worm-shaft. The eccentric rod may be adjusted along the lever operating the pawl, so as to give any rate of feed required. This change can be made without stopping the machine. The ratchet wheel is geared with the screw in such a ratio as to give a very powerful feed. An automatic trip is provided for stopping the feed when the hob has finished its work. Thus no attention is required from the operator other than that of putting in the blanks and taking out the finished gear. One operator may thus run several machines or attend to the gear-cutter while operating other tools.

A rigid stop is provided, as shown in Figs. 1 and 3, against which the table saddle may be run, to give the proper depth of teeth. Instead of setting this stop by micrometer graduations, a hardened steel gage is provided which is of a thickness equal to the depth of tooth required for the desired pitch. To set the stop, the table is advanced until the hob just scratches the outside diameter of the blank. The stop is then screwed up until the gage block is held between it and the saddle, when the gage block is removed and the table advanced to the stop, giving precisely the correct depth, if the blank has been properly sized. A careless operator cannot spoil work, as is often done when the depth is set by micrometer gage.

A small plunger pump is provided which forces a stream of lubricant upon the cutter and work if desired. The knee is hollow, and forms a tank for holding this lubricant, which is conducted thither by holes in the hub of the table. For hobbing worm-wheels the spindle is adjusted to a position central with the blank, the automatic feed being thrown out. The saddle is then fed inward along the knee by hand until the teeth have been cut to the proper depth.

The capacity of the machine is for blanks up to 12 inches in diameter and 6 inches face. The spindle is driven by a pulley 15 inches in diameter, for a 4-inch belt. The cone pulley at the rear provides for three speeds, and is driven by a 2½-inch belt from the overhead counter-shaft. Either a single or two-speed counter-shaft will be provided. The hobs are regularly right-hand, single thread, 3 inches in diameter, and 3 inches long, with 1¼-inch arbor hole. Other sizes, of course, may be used. The hob may be moved axially so that the entire length can be used before sharpening is required.

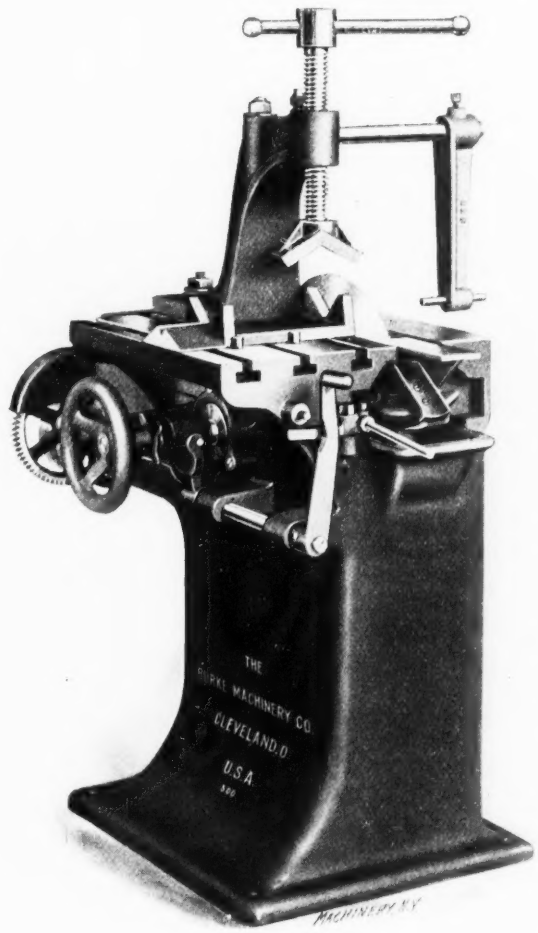
This tool should be an exceedingly useful one for work within its range, which includes automobile gearing and change gearing for machine tools. The manufacturers claim that the output is far ahead of that of any other type of gear-cutter for spur gears, on the sizes to which it is adapted.

BURKE MACHINERY CO.'S CUTTING-OFF SAW.

Few machine tools have been developed so rapidly during the past few years, and in few lines have so many new and radically different designs been brought forth as in the territory of cutting-off machines. In the accompanying half-tone engraving, a new 12-inch cutting-off saw is illustrated, presenting a number of interesting features. The machine consists principally of a main column or frame, provided with ways in which the saw carriage travels. This saw carriage supports the driving worm and worm-wheel and the saw itself, which is bolted directly to the worm-wheel. At the front of the saw carriage is mounted a hardened steel casting which acts, at the same time, as a guide for the saw and as a stripper for carrying away the chips from the saw teeth. The worm shaft is driven by means of a key, mounted in a gear sleeve, placed at the rear end of the frame, this gear sleeve in turn meshing with a pinion on one end of which is mounted the driving pulley. For actuating the feed mechanism, the same pinion engages with a system of gearing driving a worm shaft on the outside of the machine, through which power is transmitted to a worm and worm-wheel, the latter of which has square jaws cast on one side. A sliding clutch engages with these jaws, and a cross-shaft is thereby operated, having at one end a pinion engaging with a rack, which is mounted on the lower side of the saw carriage. This latter travels over an oil-pan, cast in the frame of the machine, which permits one inch of the saw-blade to be at all times immersed in oil.

At the front of the machine is mounted a lever, actuating the outer part of the feed engaging clutch, the clutch being

held out of engagement by a spring. When the saw is running, and this lever is pulled over until the clutch engages, the lever is held by a catch on the front of the machine. Through one end of this catch is passed a short rod, which can be set so that the clutch is automatically tripped at any



Burke Machinery Co.'s New Design of Cutting-off Saw.

desired position, the carriage coming in contact with the end of the rod, thereby throwing out the catch and permitting the lever to return to its original position. Between the driving pinion and the feed worm-wheel shaft is mounted a gear held in position by flanges lined with leather, while a spring mounted on the shaft carrying these flanges gives the necessary compression between the flanges. The compression can be increased or diminished by the tightening or loosening of a nut turned by hand.

The size of machine illustrated will cut circular stock up to 3 inches in diameter, or I-beams up to 5 inches high. The travel being 9 inches, permits flat stock 9 inches wide to be cut off. A guide block is furnished for small round or square stock, as well as suitable clamping device for holding the stock in position. When these devices are not in use, the machine presents a large clamping table with no part of the machine projecting above it, and this permits a great variety of work to be done on the machine. Iron can be cut off at various angles, sprues on castings can be removed, and many other operations performed which cannot be carried out on cutting-off saws of ordinary type. The machine shown in the half-tone is provided with a single pulley drive, but for machines which are to be used for cutting-off tool steel, machine steel, cast iron, and brass, where a large range of cutting speeds would be desirable, a cone pulley may be placed on the driving shaft instead of the standard tight and loose pulley, and a suitable counter-shaft is furnished.

Owing to the construction of the drive, back lash and torsional strain are eliminated, which is so common in arbor-driven saws, constructed with a worm-wheel on one end of the saw arbor and the saw on the other, with the bearings in the center. The makers have found from their own experience that, on account of this fact, the machine can very successfully be used in sawing tubing, by using a fine-tooth saw and clamping the friction clutch tightly. In order to prevent the chips from the saw from getting into the worm-wheel, a gear case covers this entirely.

A 20-inch saw is also being prepared for the market by the makers, the Burke Machinery Co., 1837 Thirty-fifth St., Cleveland, O. This saw will have a capacity for cutting off 5½-inch diameter round stock and 12-inch I-beams.

BLISS PRESS FITTED WITH STAGGER FEED.

A considerable saving of stock can be effected in blanking round shapes, by cutting them from a sheet of stock in rows "staggered" with each other, instead of cutting them in series from the strip as is usually done. Various plans have been tried for guiding sheet stock in the blanking press, so that the alternate rows of holes will be staggered with each other, but most of these have been complicated in design and unsatisfactory in operation. The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., has recently designed and patented an arrangement of great simplicity for effecting this. It is shown in the accompanying engraving, applied to a press of the single pitman, inclinable type.

The sheet from which the blanks are to be cut is placed on the table and fed against a stop finger, which, together with the back gage, locates the work for the first cut. The press being operated continuously, after the first blank is separated, the stock is again shifted against the stop finger and the ram comes down again; pressure is applied to the sheet continuously to bring it against the finger gage, and the operation is continuous. As the sheet progresses, the scrap is sheared off by means of a knife which cuts a true and straight edge for gaging on the second run.

The sheet having been passed through once to punch out the first row of blanks, a treadle is pressed which brings a

Bliss Press fitted with a Special Feed which staggers Alternate Rows of Blanks, and thus saves Stock.

second stop finger into play, set at a distance of about half the diameter of the blank from the first stop finger. By this means the cut on the second row is started in a position between the two first cuts in the previous row. In the second stroke of the plunger, this stagger feed finger is automatically released and the operation continues, as before, to be gov-

erned by the back stop and regular stop finger. On every alternate row the operator throws this secondary finger into engagement.

As an illustration of the saving it is possible to effect, the case may be taken of a sheet of tin 20 x 28 inches from which it is desired to cut blanks 2¾ inches in diameter. By the ordinary method of slitting the tin into strips and running them through the press, 70 blanks could be obtained from the sheet. By the method of feeding provided in this machine, 76 blanks may be cut from the same sheet. Another case to which the machine has been applied is in the manufacture of bottle caps, for which a 1½-inch blank is necessary. With the usual arrangement, 234 blanks could be obtained from a sheet of tin; with the method used in the press shown, the same sheet yields 270 blanks. This shows very plainly the advantages to be obtained from the use of the device.

The mechanism is designed for continuous and rapid operation, and the gage system is so accurate that decorated stock can be successfully handled. Another feature of the device is the fact that the knives for separating the scrap remove it entirely from the blanks, and cut it into small pieces, thus greatly facilitating the work of disposing of it.

STEAM TURBINE DRIVEN OIL EXTRACTOR FOR CHIPS.

Figs. 1 and 2 illustrate a simple but ingenious machine made by the Oil & Waste Saving Machine Co., 1307 Real Estate Trust Bldg., Philadelphia, for extracting oil from chips, turnings, etc. The important feature of this construction is the fact that the spindle is driven by a direct connected steam turbine of the impulse type. The exhaust steam from this is led through the chips from which it liberates the oil so thoroughly that the centrifugal force effects a nearly perfect extraction, thus leaving the contents of the basket in a dry condition.

The machine is well arranged for rapid and convenient operation. The machine is shown in Fig. 1 at work extracting the oil, and in Fig. 2, with the basket of chips lifted from the body. The removable basket in which the chips are placed rests on the turbine disk or rotor, and is held in

Fig. 1. Centrifugal Oil Extractor for Chips, driven by a Steam Turbine, and using the Exhaust for Freeing the Oil.

place by an inner cover clamped by the smaller of the two hand-wheels shown attached to the radial arm projecting over the machine from the column at the rear of Fig. 1. The lower hand-wheel is used for raising and lowering the outer cover of the casing. These two covers, when raised, may be swung back out of the way on the arm which carries them.

For raising the chip basket from the machine, a steam hoist is used. This consists of a plunger fitted into the cylindrical body of the column at the rear of the machine and provided with a swinging crane arm and sling for grasping the basket as shown in Fig. 2. Steam is admitted beneath the ram by a hand operated valve. The hoist is automatically held at the upper extreme of its travel by a catch, so that it is not necessary to keep the steam pressure on constantly. When so held, the basket may be swung out to one side and the dry chips dumped into any convenient receptacle. To replace the basket after filling it (either from a chute or by shoveling) the hoist arm is swung back into position, and the catch pulled out, allowing the plunger and basket to descend. The latter is so arranged that it seats itself in position on the rotor. The arms carrying the basket and the cover are ar-

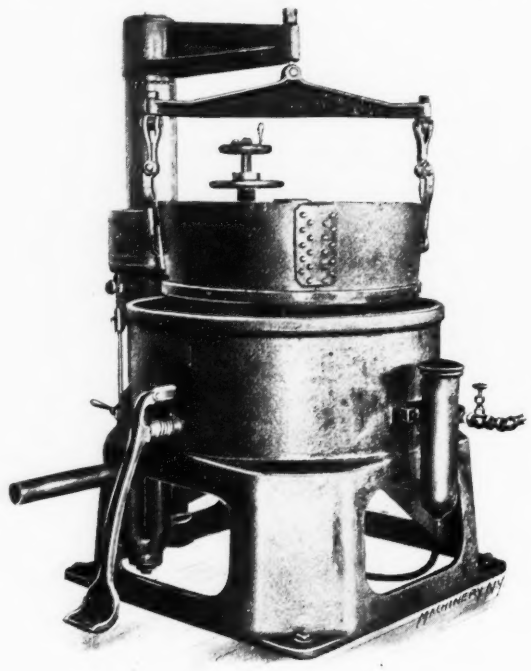


Fig. 2. Using the Steam Hoist to lift the Basket from the Separator.

ranged with ball and roller bearings so that the entire operation of loading and unloading, exclusive of filling the basket, lasts but two or three minutes. The extraction of the oil is thoroughly accomplished in six or eight minutes. The oil is discharged from the pipe seen projecting from the left side of the base. The reservoir at the right side is for supplying lubricant to the step bearing.

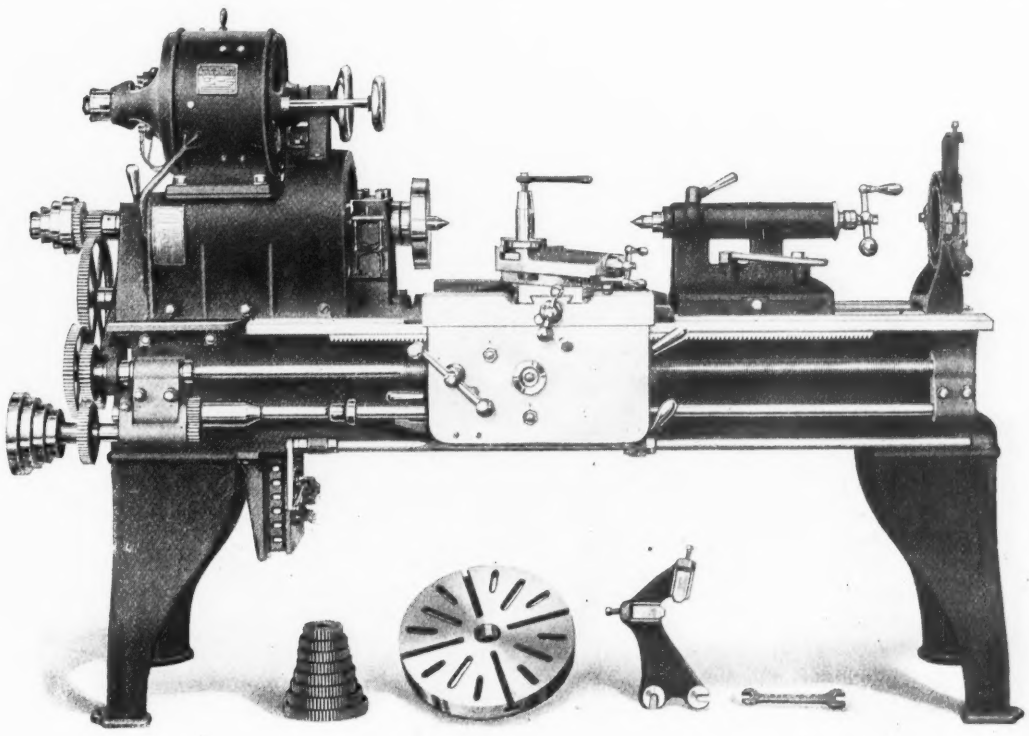
The machine has a basket capacity of 3½ cubic feet, or very nearly three bushels. It is now in operation in a number of plants throughout the country, and has proved to be very satisfactory. It is a development of the makers' waste reclaiming machine, which separates the oil by the combined action of steam and centrifugal force obtained from a steam turbine in the same way as here described. The absence of troublesome quarter-turn belting and high-speed counter-shafts is a very favorable point in the design.

RAHN-CARPENTER 16-INCH MOTOR-DRIVEN LATHE.

The Rahn-Carpenter Co., Cincinnati, Ohio, is applying to its line of engine lathes the style of motor drive shown in the engraving. The use of a variable speed motor and the convenient location of the controlling mechanism make the arrangement a most satisfactory one.

The motor used is the Lincoln variable speed machine which we have previously illustrated. (See "New Machinery and Tools in the March, 1906, issue of MACHINERY.) In this motor no electrical controller is required. The turning of the small hand-wheel projecting from the front of the motor frame moves the cone-shaped armature longitudinally. When it is by this means withdrawn from the taper pole-pieces, the air gap and consequently the magnetic reluctance is increased, decreasing the magnetic flux and increasing the number of revolutions per minute. A speed ratio of 8 to 1 is given by this means, with infinite gradations, the number of changes not being limited by the number of contacts on a controller. This ratio of 8 to 1, combined with the back gear ratio, covers the entire range required on a lathe of this size.

Since no controller is required, a simple starting box only is used, placed beneath the head-stock end of the bed. This is operated by a splined shaft running lengthwise of the bed, connected with a handle at the left of the apron, convenient to the operator at all times. The motor is reversed by the double throw switch shown on the front bearing of the head-



The Rahn-Carpenter 16-inch Lathe as arranged to be driven by a Lincoln Motor.

stock. When set for any given speed the motor maintains that speed almost constantly under varying loads, the drop in speed from full load to no load comparing favorably with the best constant speed motor practice. The special commutator poles provided prevent sparking at all speeds, even with as high as 50 per cent overload.

It will be seen that the motor is mounted low down on the head-stock, close to the spindle, so that the top-heavy construction often found in electrically-driven lathes is avoided. This tends to steadiness of running and consequent accuracy of work. The armature and the spindle are connected positively by gearing. The head-stock is well ribbed and firmly bolted to the bed. The spindle is of high-carbon steel, ground, running in adjustable boxes of the best gun metal.

The lathe, in general, fills the requirements for modern practice with high speed steel. It is rigid and simple in construction, accurate and easy to operate. The carriage is gibbed to the bed both front and back, with a broad bearing for the rest. The apron is of simple design, with all feeds convenient to the hands of the operator. The rack and all the gears are made of steel, and the stud pivots are hardened and ground. The change gearing connects the lathe spindle and the lead-screw directly, and is very simply set for any thread within the range of the machine, it being necessary to change only the gear on the lead-screw.

AUTOMATIC SLOT MILLING ATTACHMENT TO GARVIN MILLING MACHINE.

In the accompanying half-tone and line engravings we show an attachment recently devised by the Garvin Machine Co., Spring and Varick Sts., New York, for automatically operating the milling machine for performing such work as milling drift slots in taper sockets, cutting slots in tool-posts, milling keyways with end mills, and other similar operations in which a groove or slot is cut by feeding successively deeper and deeper with an end milling cutter. The function of the attachment is to feed the carriage back and forth within limits determined by the required length of slot, at the same time feeding the saddle in toward the column by a small amount at each reversal. An automatic stop is also provided for arresting the cross feed movement when the proper depth of slot or keyway has been reached.

The device is operated by the regular telescopic feed shaft of the machine. The mechanism for controlling the automatic movements is attached to the side of the regular feed box as shown in Fig. 1. The mechanism will best be understood from the line drawings, Figs. 2 and 3. Shaft *A* runs constantly in one direction, driven by the telescopic feed shaft. It is connected with worm *B*, driving the feed worm-wheel *C*, by tumbler gears *D* and *E*—a part of the regular mechanism of the machine. Shaft *A* is also geared with and drives sleeve *L*, from which, as will be explained, the controlling movements of the attachment are operated.

Stops *G* and *G'* are adjusted in the T-slots under the front edge of the table to agree with the range of movement required for the length of slot or keyway which is to be cut. These stops act on plungers *H* and *H'*, whose lower ends in turn rest upon and actuate a cross arm attached to lever *K*, pinned to rock shaft *J*. This rock shaft carries at its inner end a fork *Q* whose arms encircle the hub of clutch member *O*, keyed to shaft *F*. Springs *M* force this sleeve forward against clutch body *N*, keyed to sleeve *L*, which latter is driven constantly (as before explained) from shaft *A*.

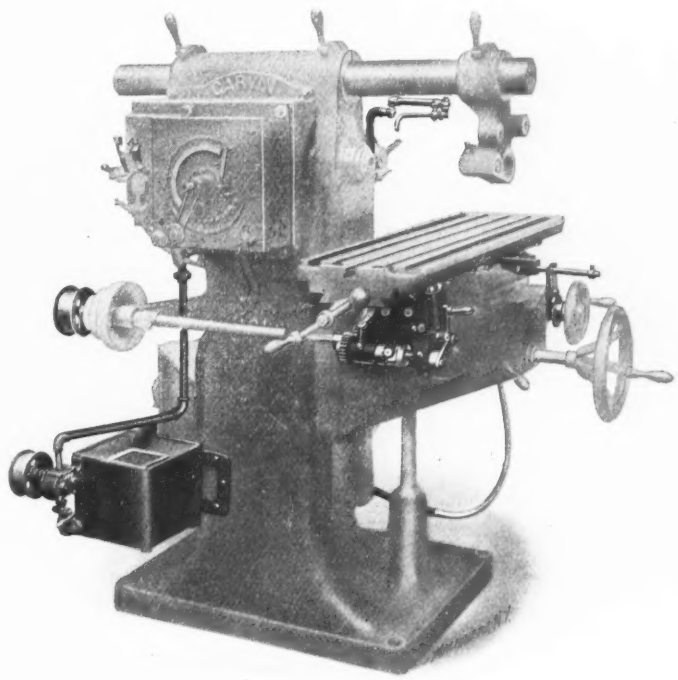


Fig. 1. Automatic Slot Milling Attachment applied to Garvin Plain Milling Machine.

With the table traveling in the direction of the arrow in Fig. 3, stop *G* presses down the top of plunger *H*, rocking shaft *J* so that the right-hand arm of the fork is raised while the left one is brought inward toward the hub of member *O*. By the action of a cam surface on *O*, the latter is by this action released, and allowed to be forced inward by springs *M*, until

the multiple disk friction clutch contained in N engages revolving sleeve L to shaft F. When a half revolution of F has taken place, the cam surface on O engages the pin in that arm of the fork which is now depressed and runs up on it, thus releasing the friction and arresting the rotation. At the outer end of F is a crank disk with a crank-pin P connected by the link, as shown, (see also Fig. 1) with a mechanism for operating the tumbler gears by which the feed is reversed.

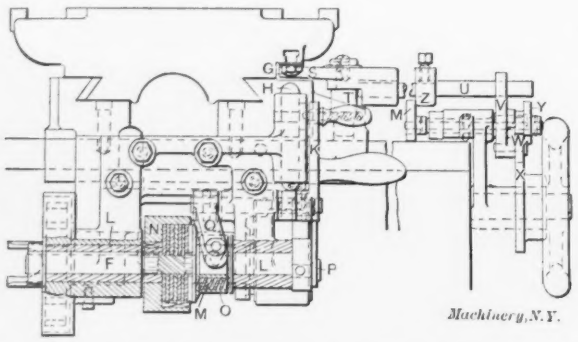


Fig. 2. Section through Reversing Mechanism attached to Feed-box of Milling Machine.

From this it will be seen then that when G strikes H, the half revolution thus given to F by the shifting of fork Q throws the tumbler gears over and reverses the direction of rotation of B, and consequently the direction of the feed. The table now moves in the opposite direction from that indicated by the arrow, until stop G' engages stop H', which rocks arm Q in the other direction, allowing another half revolution of F, again throwing the tumbler gears, by means of crank-pin P and the attached link, backward. The reversal of the table feed is thus seen to be automatic and continuous.

The cross movement, feeding the end mill at each reversal of the table movement, is effected by stops R and R' located in the same T-slot which carries G and G'. These dogs alternately strike lever S, which is pivoted in a vertical axis about stud T. Rod U, which is an extension of lever S, is thus vibrated back and forth as the table is reversed. Rod U engages a slot in lever V, to which (above and below its pivot) are attached pawls W and W', engaging ratchet wheel X keyed to the cross feed shaft. Paul W, it will be seen, acts on the right-hand reversal, while pawl W' acts on the other. A cam Y may be thrown to raise both pawls out of engagement with X to stop the feed. The rate of inward feed is adjusted by setting stops R and R' to give greater or less swinging movement to U.

As was stated previously, however, an automatic feed stop is provided which arrests the feeding of the saddle on the knee when the proper depth of cut has been reached. This is accomplished by setting dog Z at the proper position on rod

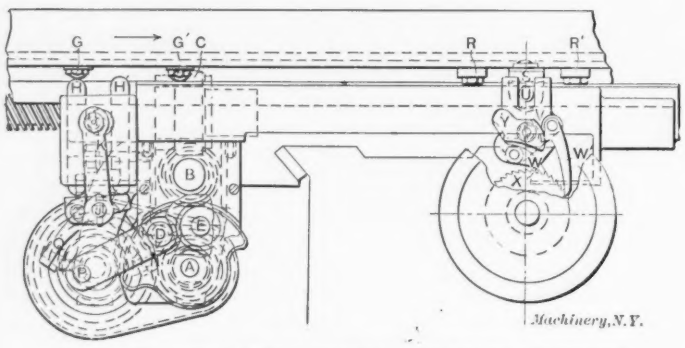


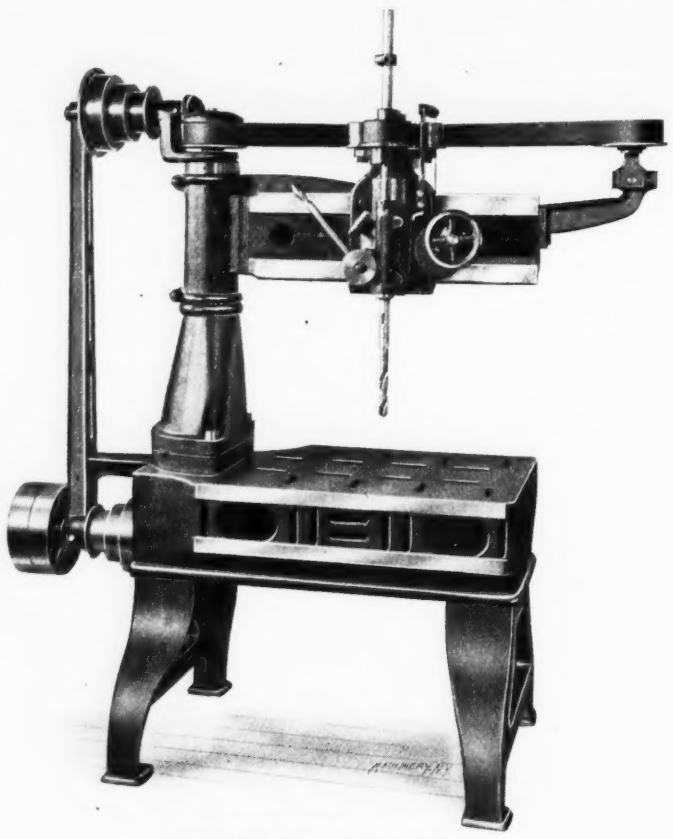
Fig. 3. Front View of Reversing and Cross-feeding Mechanisms.

U, so that when the desired inward movement of the saddle has been effected, Z will strike tappet M as the lever U is thrown over at the reversal, thereby drawing inward, strongly, cam Y, which is attached to the same pivot as M. This pressure on Y prevents pawls W and W' from falling back into the ratchet on the backward stroke, thereby stopping the feed.

An especially notable feature of this device is the fact that it effects complicated automatic movements in a plain machine of standard type. The attachment is comparatively simple and need not be removed from the machine when the latter is being used on regular work. It is simply necessary to uncouple the rocker actuated by plungers H and H' from lever K, this being done by a small screw at the front of the machine. The feed is reversed by hand by a small handle seen at the front of the speed box. Pump and piping, as shown, are essential for washing the chips out of the slot being milled. These will be provided when ordered. The attachment can be applied to the Nos. 12, 13, 13½ and 14 milling machines, and the No. 2 universal machine made by the builders.

NEW SENSITIVE RADIAL DRILLING MACHINE.

The machine here illustrated forms the first of a range of sizes designed more especially for dealing with bulky and awkward castings, etc. The box-section table, the working surface of which is 3 feet 6 inches by 2 feet, enables angle plates to be dispensed with, and, of course, permits long work to be operated on at the ends. The arm, which is well ribbed, swings on the column, and can be locked in any position. The spindle, which is of tool steel, is 1 inch in diameter, and is



Radial Drill Press of English Design.

belt-driven as shown, a tightening device being provided for the belt. The spindle revolves in a long sleeve which has an adjustable cap. The thrust is taken on ball bearings. The driving pulley of the spindle revolves in a long bearing, relieving the spindle of strain, irrespective of the tightening of belt. The head is moved along the arm by rack and pinion operated by the hand-wheel shown. The pulleys are turned all over to insure correct balance, and have a long bearing on their studs. The usual adjustable collar is provided on the spindle for repetition work. The machine being self-contained, as regards the counter-shaft, can be driven direct from the line shaft, the steps of the three-speed cone pulley taking a 2-inch belt. The fast and loose pulleys are 10 inches diameter by 2½ inches wide. The vertical movement of the spindle is 5 inches and that of the sliding head 8 inches. The spindle is bored to take No. 2 Morse taper. The distance from the arm to the table is 18 inches; the maximum distance from center of spindle to center of column is 2 feet 6 inches. The counter-shaft is speeded from 280 to 340 revolutions per minute, and the floor space taken up by the base is 4 feet 4 inches by 2 feet 6 inches. The machine weighs about 1,200 pounds, and is built by A. Haworth & Co., Luton, England.

J. V.

SELLERS HIGH-POWER DRIVING-WHEEL LATHE.

There is no better example of the great efficiency that can be obtained from machine tools specialized for definite operations, than the modern driving-wheel lathe as developed for the work of the railroad shops. These have been continually increased in rigidity and driving power, taking advantage of the new-found possibilities in high-speed steel, until at the present time the matter of handling the work, clamping it in place, changing and adjusting the tools, etc., has become of greater importance than the time spent in the actual turning operations. This being the case, the recent developments in this line of machinery have been particularly directed toward the matter of securing greater convenience and rapidity of operation, and, at the same time, all the advantages of high cutting power are retained. A recent and most interesting example of this development, the driving wheel lathe built by Wm. Sellers & Co., Inc., of Philadelphia, Pa., is herewith illustrated and described.

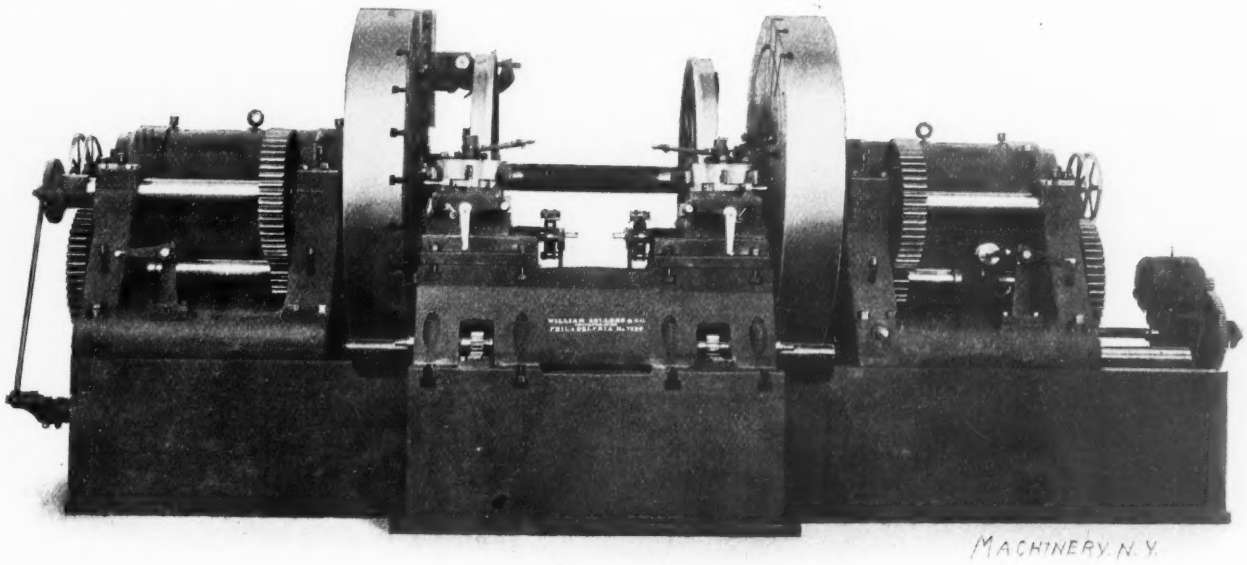


Fig. 1. The Sellers High-power Driving-wheel Lathe.

Head-stock Driving and Adjusting Mechanisms.

As may be seen in Fig. 1, the lathe consists of a bed on which are mounted two head-stocks carrying heavy spindles and face-plates, and a tool bench carrying two tool slides, one for each wheel. The machine is electrically driven, the main motor being partially seen at the rear in the end view of the machine in Fig. 3. Power is transmitted to the right-hand head of Fig. 1 by the heavy splined shaft shown running lengthwise of the bed beneath the face-plate. The end view of the machine in Fig. 3 best shows the driving connection. This splined shaft is provided with a pinion meshing with a gear on an intermediate shaft, which in turn meshes with a gear on the driving pinion shafts. The driving pinion engages internal gear teeth in the rim of the face-plate. The connections for the movable head are similar, except, of course, that the first pinion of the train is splined onto the driving shaft and moves with it as the head-stock is adjusted.

The pinions for driving the face-plates are located in nearly the same horizontal plane as the tools, and on the same side of the center. The cutting strain is thus transmitted directly through the face-plate and drivers without imposing any pressure on the spindle bearings. The spindle caps are made in one continuous piece for each head, producing a nearly solid support for the hardened steel step which is placed at the end of the spindle for taking the thrust. Secured to the face-plates are flanged bearings through which the sliding center spindles pass, which support these spindles and reduce their overhang when extended into the work. These bearings are supplied with split taper bushings for taking up the wear and maintaining an easy fit without allowing lost motion and consequent chatter. When desired, these bushings may be closed tightly on the spindle, thus forming an additional clamp.

The motor provided for driving the lathe is of ample size and has a speed range of 2 to 1, which, together with the mechanical change provided, controlled by the handle seen at the front of the left-hand end of the head stock in Fig. 1, gives spindle speeds of from ⅜ to 1½ turns per minute, with numerous intermediate steps.

The small motor shown at the extreme right-hand end of the bed in Fig. 1 operates a screw by means of which the left-hand head-stock is shifted outward for removing the work, or inward for placing the work on the centers. It does not drive the screw positively but through the medium of a friction clutch, which will slip if the mechanism meets with undue resistance, such as would be the case, for instance, if it were attempted to throw in the traversing movement before the head-stock clamping bolts had been loosened.

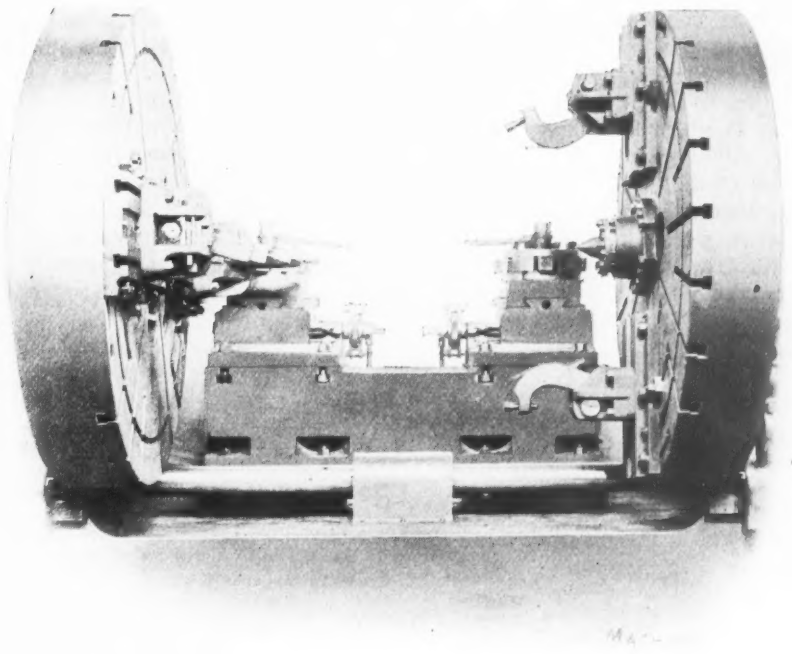


Fig. 2. View of the Double Face-plates showing the Floating Drivers.

The Wheel Clamps or Driver.

A most important feature of the machine is the means provided for driving the work. With the tremendously heavy

cuts taken, the rim of the wheel must be so held that there is no possibility of slippage. The drivers used are best seen in Fig. 2. There are two on each face-plate, located at right angles to each other, as required for the "quartering" of the driving wheels. The drivers consist of slides bolted to the face-plate, carrying holders in which are supported drivers of the C-clamp order. These are so mounted that they float in the holders, being pivoted horizontally (in the position shown

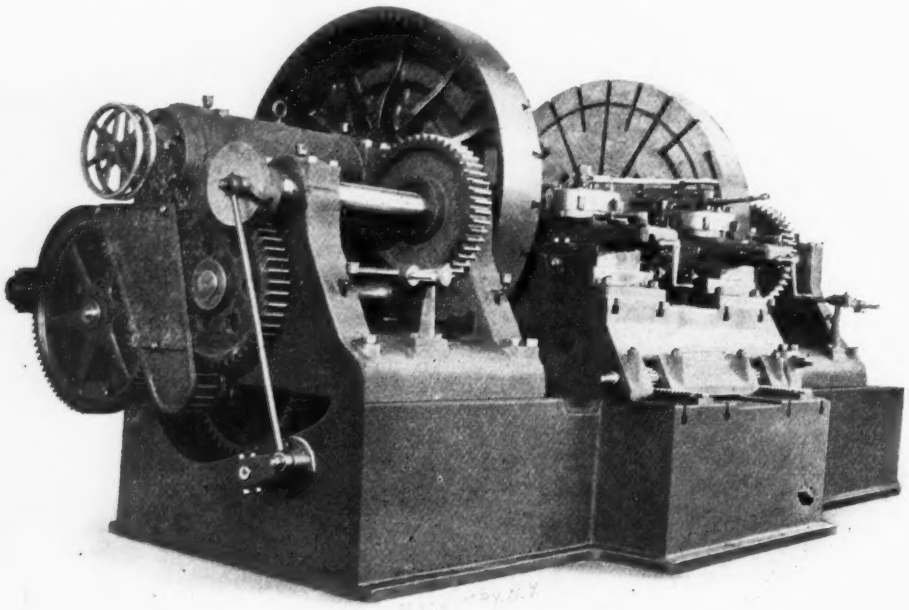


Fig. 3. End View, showing Driving Gearing and Feed Motion.

at the left of Fig. 2) in a block which itself is pivoted about a vertical axis in the holder. The pivot which provides for this latter movement has considerable play in the holder, so that the clamp can adjust itself within limits to the position of the rim of the wheel.

In Fig. 2 the drivers are shown in three positions. The upper one to the right is held by a spring latch in position for inserting and removing the wheel. The one beneath it is unlatched and in position for clamping. When the face-plate is revolved, the drivers will automatically open and latch. The driver on the left shows the gripping jaw in the floating block to which the clamp is pivoted. After the clamps have been swung in under the rim and tightened down, any tendency of the work to slip at once cants the C-clamps about their radial pivots, thus more tightly gripping them on the work. By this means assurance is given that the driving power is always sufficient for the work in hand, and this is done without side strain on the wheel rims. A further ad-

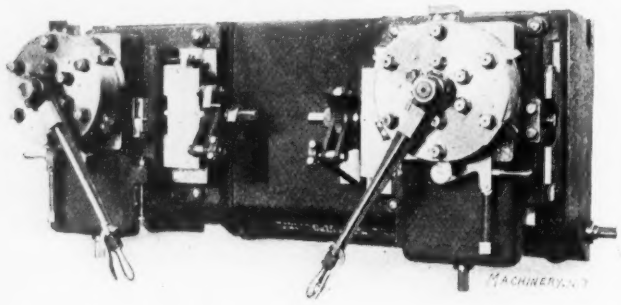


Fig. 4. Top View of Tool Bench, showing the Two Tool Turrets and the Slides on which they are mounted.

vantage is that the drivers are self-contained, without loose parts to be removed or replaced in changing wheels. They are clamped by one set-screw by an ordinary short wrench, the clamping action previously described being depended upon to give the necessary power for driving. It will be seen that these drivers can be manipulated with great rapidity.

As may be seen in Fig. 2, the slides on which the drivers are mounted may be adjusted through a limited distance for angular position about the axis of the spindle. This makes provision for wheels having both odd and even numbers of spokes. Graduations are provided for this angular setting, as well as for the radial position of the drivers on the slides, so that the operator can set the machine for the number of spokes in the wheels and the inside diameter of the rim before the work is placed between the centers. To change from the setting from that for wheels of right-hand lead to that for left-hand lead, the driving pinion for the head at the left of Fig. 1 may be thrown out of engagement with the gear it meshes with, by means of the handle shown at the front, operating the rack and pinion withdrawing movement. This disconnects the face-plate from the driving shaft, so that the other one may be revolved for 180 degrees, after which the connection is again thrown in.

Provisions for Holding and Feeding the Tools.

The bench (see Fig. 4) on which the tool slides are mounted is supported on a forward extension of the bed. It is adjusted in and out on this extension for the diameter of the work by means of a rack and pinion movement, operated by a ratchet wrench, as plainly shown in Fig. 1. The slide rests mounted on the bench are heavy and capable of taking heavy cuts. The bases of these rests are arranged to swivel on the bench to accommodate different angles of wheel tread. The slides are each provided with a ratchet feed motion, connected by a ball jointed rod with a rock shaft in the bed of the lathe. This rock shaft is operated by a slotted crank on the right-hand driving pinion shaft, as is best seen in Fig. 3. The adjustment of the crank-pin toward or away from the center of the crank determines the rate of feed.

Each slide rest carries a cross slide on which is mounted a tool-carrying turret. The mounting of the tools for this machine in a turret is an important improvement, securing great rapidity of operation. These turrets (as is best seen in the top view of the tool bench in Fig. 4) are located in position by manually operated locking bolts held in place by coiled springs. The handle for locking and unlocking the right-hand turret will be seen just at the right of, and below it. The long levers pivoted above the turrets serve the double purpose of clamping and unclamping them, and of indexing them to new position. When the spring plunger is thrown into engagement with the slotted disk at the hub of the lever, the indexing movement can be operated. When the plunger is free from this disk, the movement of the lever clamps or unclamps the turret. The turrets are of steel. A micrometer screw and stop conveniently placed at the side of the cross slide enables the wheel to be rough turned to the desired diameter without calipering. The stop can be swung aside when finishing. The front of the openings in the turrets for the forming tools are made with a slight taper to fit which a corresponding taper is provided in the tool sockets. The latter are thus accurately centered and securely held against side motion. This construction also permits a reduction in

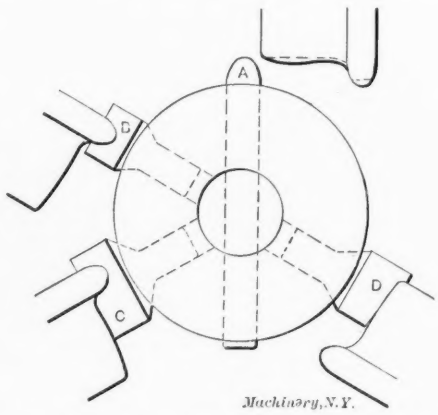


Fig. 5. Usual Arrangement of Tools for Truing up a Worn Driving Wheel.

the size of the tool body without decreasing the broad bearing surface which supports the tool near the cutting edge.

The Order of Operation.

The usual arrangement of tools is somewhat different from that shown in Fig. 4, being indicated in Fig. 5. The first tool *A* is a roughing cutter which may conveniently be made with a long shank extending clear through the turret, a hole being provided for this purpose in the central stem. The forming tools are not subject to so great wear, and may be conveniently made with shorter shanks. After the tread has been rough turned with *A*, the turret is indexed and the tool *B* is used for sizing the flange. Tool *C* is next brought into position for finish forming the flange, and a portion of the tread. Tool *D* forms the other half of the tread and rounds the corner.

The operation of a machine of this kind certainly presents a powerful contrast with that of a wheel lathe of ten or twenty years ago, whose operation was one of the "soft snaps" of the railroad repair shop.

NUTTALL FLEXIBLE INSULATED COUPLING.

The illustrations show an improved flexible insulated coupling manufactured by the R. D. Nuttall Co., Pittsburg, Pa. The coupling consists of two interlocking spiders of cast iron construction which are insulated by means of solid rubber cylinders. The only other parts are two steel rings used to hold the rubber cylinders in position. The rubber members provide ample insulation and at the same time give the desired flexibility. It is furnished in sizes from 5 H.P. up.

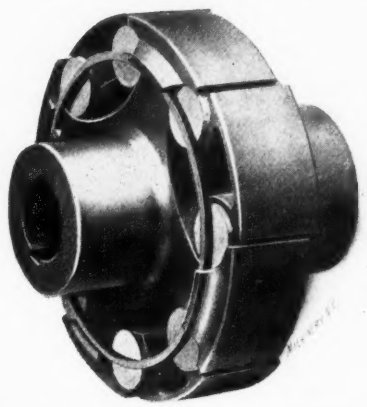


Fig. 1. Nuttall Flexible Insulated Coupling.

This flexible coupling is especially desirable where electric motors are direct connected to machinery which is subject to vibration, as, for example, a tube mill or a coal pulverizer in a cement plant, where the coupling relieves the motor from

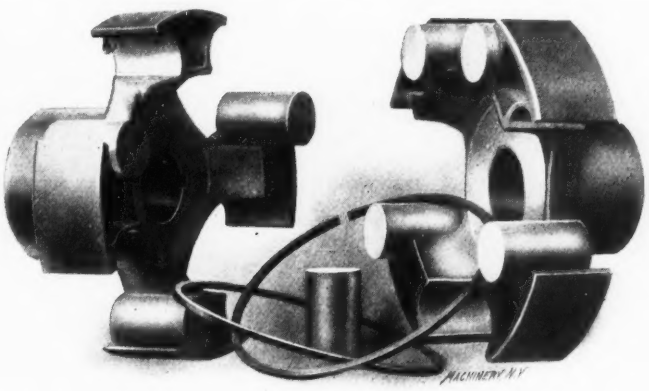


Fig. 2. Parts of Nuttall Flexible Insulated Coupling.

the shocks and jars of the machine. In addition, the end thrust of the crusher is overcome and the motor bearings run without heating.

YALE & TOWNE ELECTRIC TRIPLEX HOIST.

As is well-known, the Yale & Towne Mfg. Co., 9 Murray St., New York, has been for many years building a triplex hand-operated hoist, which has found extensive use for all purposes for which a hand hoist can be used. This company also manufactures a well-known electric hoist, which has found much favor for heavier service, particularly for eye-beam trolley systems and for use with traveling cranes. The builders of these hoists have recently placed on the market a new one which occupies a field mid-way between the other two, being a hoist of practically the same construction as their hand-operated triplex type, but driven electrically.

The front and end views of this machine are shown in Figs. 1 and 2. The arrangement consists essentially, in the case of the 1-ton electric triplex hoist shown, of one of the builders' regular 2-ton triplex hand-operated blocks, provided with a motor and a controller, the motor being mounted on one side of the block and the controller on the other, as seen best in Fig. 2. The pinion shaft of the hoist is connected by chain and sprockets directly with the armature shaft of the motor. This latter is of the series wound crane type, ruggedly constructed, and designed to take care of the varying loads and varying speeds met with in hoisting work.

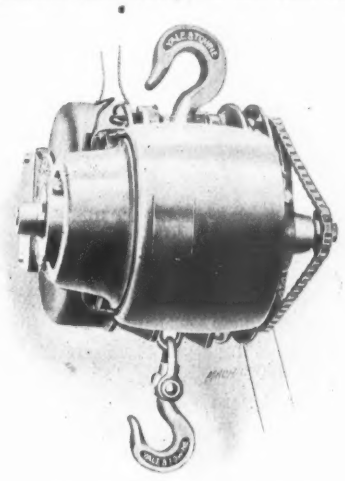


Fig. 1. Side View of the Yale & Towne Electric Triplex Hoist.

The chain drive is very efficient, and in combination with the high workmanship and good material used in the gearing of the hoist proper, insures a very low current consumption. The load is positively sustained at all times by means of a Weston brake. The gearing is shown in Fig. 3 where it is

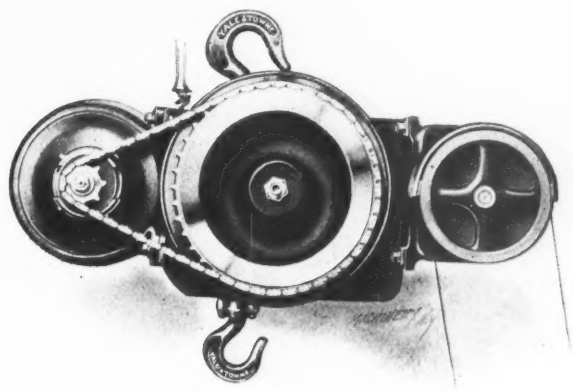


Fig. 2. End View showing Auxiliary Hand Chain Drum.

compared with that used in the hand-operated 1-ton triplex chain block, both of these being intended for the same loads. The parts have been made much heavier for the electrically operated machine, to provide for the wear and tear resulting from the more rapid and severe operation it is subject to.

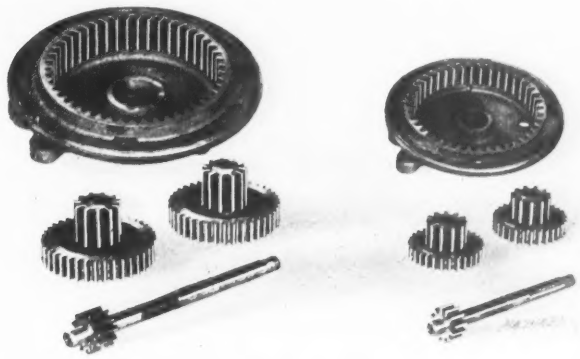


Fig. 3. Comparison of the Gears used in the Electric and Hand Operated Models for the same Load.

A convenient feature of the machine is the hand sprocket wheel with which it is provided, mounted on the same shaft as the power sprocket wheel and just behind it; as may be seen in Fig. 2. If for any reason power is not available, the hoist is not tied up, as a hand chain may be applied and the apparatus used as an ordinary triplex block. This materially increases its usefulness for a place where it is required to be

used occasionally at night, or at any time of the day when power is shut off. It is provided with a safety automatic stop to prevent over-travel of the hoist hook.

This hoist, it will be seen, is adapted to solving the problem of short frequent lifts. For handling 50 pounds or a ton it is five to ten times as fast as a hand chain block, and will do the work of several ordinary laborers. It is especially economical for serving machine tools, running on trolley track, and handling finished parts in the assembling shop. It may be attached to a small traveling crane, swinging jib crane or trolley track, or it may be lashed to shear poles or any other temporary rig. Its installation is very simple, involving simply hooking the hoist in place and attaching two wires for the current. The controller is operated by means of two pendant cords.

While designed primarily for motor service and short lifts, a recent test with this machine was undertaken in which a load of one ton was lifted 10 feet high and lowered the same distance, thirty times in two hours without injury to the machine. This, however, is heavier service than it should be required to undergo. The service for which it would naturally be used consists in lifting loads ranging from 50 pounds to a ton, to a height simply to clear the floor, or at most for a lift of 3 or 4 feet onto some machine. When operated thus, the hoist is suited for reasonably continuous service.

Although, as stated, this hoist has only recently been placed on the market, the design has been developed for some time, and a number of them have been in use in various places under severe conditions, so that it is known that the device is a thoroughly practical one in all respects.

STURTEVANT VERTICAL COMPOUND ENGINE GENERATOR SETS.

The B. F. Sturtevant Co., Hyde Park, Mass., has recently completed the design of a line of vertical compound engines direct connected to generators for small electric lighting and power plants. Success in service of this kind depends quite as much on low cost of up-keep, and freedom from continual attention, as it does upon economy measured in pounds of steam per horse-power per hour, though this latter point is an essential one in all except units of the very smallest size. To fill these conditions this line of engines has been designed, special attention being given to simplicity, reliability, durability and continued economy throughout a long life.

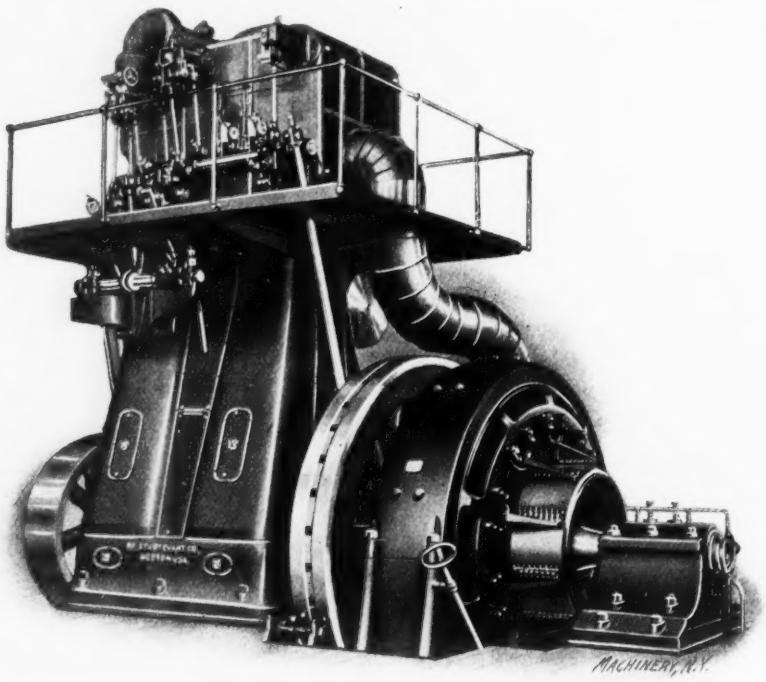


Fig. 1. Sturtevant Engine Generator Set, adapted for the Factory Power Plant.

The item of economy requires that the engine shall be made compound, since steam can be used more economically with a comparatively simple valve gear in two cylinders than can be done in any possible single cylinder design of engine, even though every refinement known to the engine builder is used. The steam distribution is effected by six valves of the gridiron type for each cylinder—two exhaust valves, two steam valves and two cut-off valves riding on the steam valves. Exhaust valves and main slide valves are driven by eccentrics fast to the main shaft, while the cut-off valves are operated by an eccentric controlled by the governor, which is a modification of the well-known Rites inertia type, placed in a separate fly-wheel. This governor is sensitive enough to regulate the speed so that the variation between no load and full load is less than 2 per cent—sufficiently close for electric lighting. This form of valve gear tends toward high economy, and it permits the cut-off to be adjusted without in any way altering the other functions of the steam distribution, giving the same results as are obtained with the Corliss valve gear. The valves are placed in the cylinders, so that the heads can be removed without disconnecting the valve-gear.

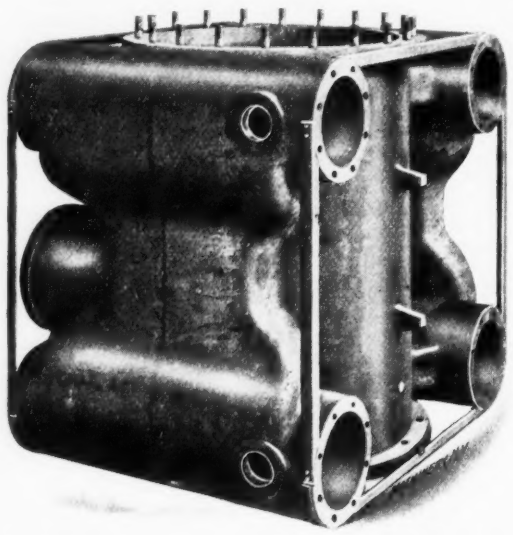


Fig. 2. Method of attaching the Lagging to the Cylinder Casting.

The reciprocating parts are enclosed by a cast iron frame, but are rendered accessible by the removal of oil-tight cover plates or doors. A water shed partition is provided at the top of the frame which prevents the water from the stuffing box from becoming mixed with the lubricating oil in the base. The entire engine is equipped with a system of forced lubrication which positively and automatically supplies oil to all bearings, under a pressure of from 10 to 20 pounds per square inch. A small, independent pump forces oil through the crank-shaft web and crank-pin to the connecting-rod, and through the connecting-rod to the cross-head pin. This continuous supply of lubrication reduces friction to a minimum, and makes it unnecessary to make adjustments in the wearing surface except at long intervals.

A neat detail of the design of these engines is the method of supporting the lagging, shown in Fig. 2. As will be seen, the cylinder casting itself is of simple form, both high- and low-pressure cylinders being exactly alike except as to diameter. Angle irons are beveled off to fit the cylindrical surfaces of the valve chambers on each side, as shown, and these furnish the framework to which the lagging is easily attached. The cylinder thus does not have to be complicated to furnish supports for the lagging, though the latter is properly held and applied in a very neat and simple fashion. Provision is made for using indicators without disturbing the lagging or opening the doors of the oil-tight casing.

These engines are made in sizes ranging from 225 indicated horse-power and 150 kilowatt capacity, to 750 horse-power and

500 kilowatt capacity, running from 200 to 160 revolutions per minute. The generators are of the 10-pole type manufactured by the builders, directly connected to the engine shafts by a flanged coupling. They are capable of carrying an over-load of 50 per cent for 2 hours without serious sparking. The insulation will not deteriorate after continuous operation at normal temperature.

The design of these engines is the result of filling the requirements of the builders for their own factory power plant. They proved so satisfactory for the use to which they were applied, that they are now furnished as a regular product of the company, and are recommended as specially adapted to medium-sized factory and power plants.

WILMARTH & MORMAN COMBINATION DRILL, CUTTER, AND REAMER GRINDER.

The well-known "Yankee" drill grinder made by the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., is shown in Fig. 1 provided with an attachment for grinding cutters and reamers. This adapts the tool to doing nearly everything required for keeping the cutting tools in condition in the average tool-room. The attachment is of substantial construction, and is firmly attached by a bracket to the main column

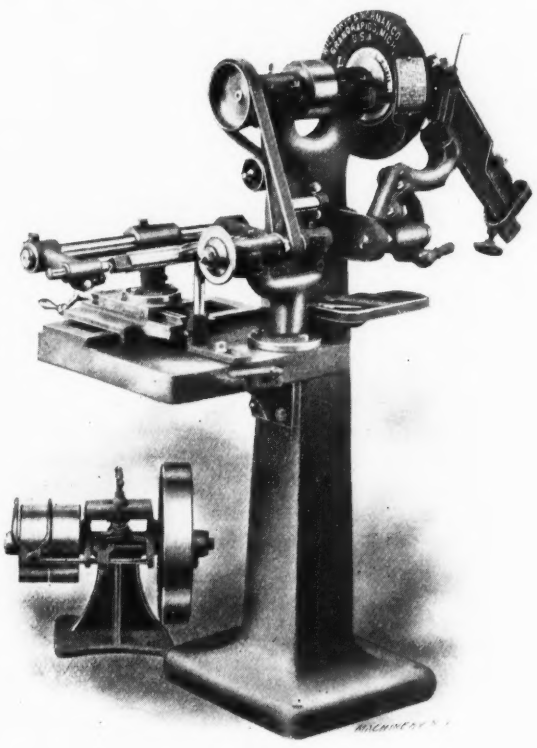


Fig. 1. The Yankee Drill Grinder provided with a Cutter and Reamer Grinding Attachment.

of the machine. It may be supplied with any of the grinders made by the builders, so that the entire equipment will be suited to the range of drills and cutters used by the purchaser.

As may be seen in Fig. 1, the spindle of the attachment is driven from a pulley on the main spindle of the machine by a belt which passes over an idler so that the proper tension may be maintained. The stand which carries the spindle is mounted on a table which forms the base of the attachment. This table is provided with dove-tail ways on which is mounted a slide operated by a hand lever from beneath, as is more plainly seen in Fig. 2. This slide carries dove-tail ways extending at right angles to its line of movement, on which is mounted a second slide, operated by the screw and ball crank shown. This second slide in turn carries a swiveling head which may be adjusted so that the bar it carries may take any position between that parallel with the wheel spindle, and one at right angles to it.

In Figs. 1 and 2 the operation of grinding a reamer is shown. The head which is adjusted in parallelism with the wheel spindle carries a bar provided with centers on which the reamer is supported. A tooth rest is furnished which supports the tooth of the reamer just under the point where it is being ground, so that the hand of the operator may cause the reamer to follow the spiral path of the tooth as the slide is moved back and forth by the hand lever. The adjustment for diameter is, of course, obtained by the ball crank and adjusting screw.

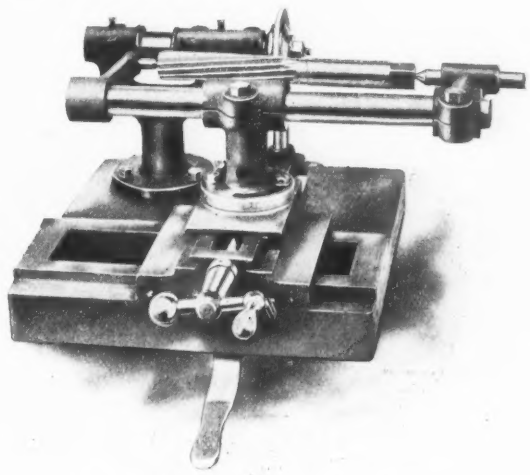


Fig. 2. Grinding a Spirally Fluted Reamer.

The operation of grinding a face mill is shown in Fig. 3. In this case the tooth rest is mounted in the work-carrying head, and moves with the cutter as it is shifted back and forth past the edge of the wheel by the operation of the handle. For grinding the periphery of the cutter, the head is swung around

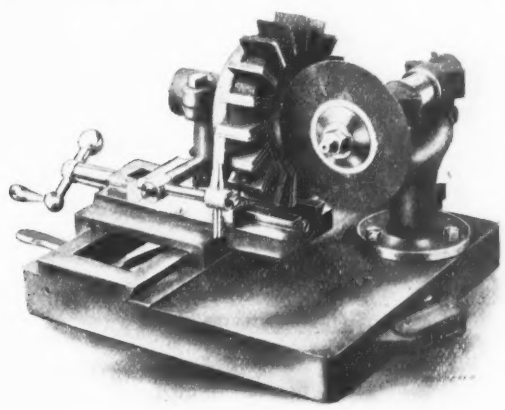


Fig. 3. Sharpening the Face of an Inserted Tooth Cutter.

through 90 degrees to present the other edge of the inserted blades to the wheel. In Fig. 4 a 45-degree angle cutter is being ground in the same manner, though with the head set, of course, to the proper angle. The proper clearance is readily obtained by adjusting the height of the spring tooth rest.

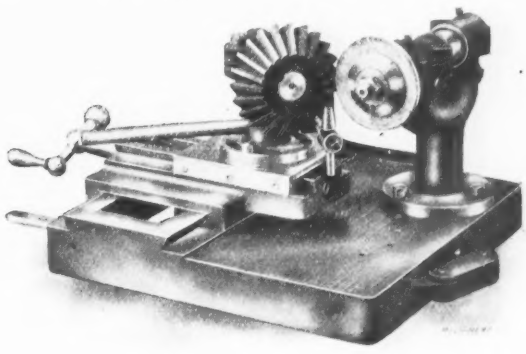


Fig. 4. Grinding a 45-degree Cutter.

The method of formed cutter grinding employed is shown in Fig. 5. A gear-cutter is here being sharpened. A special attachment is used in place of the swiveling head previously shown. This attachment comprises a small table mounted on the cross slide, which table carries a vertically adjustable stud on which the cutter is placed. In setting the device to grind the teeth of the cutter radially, the sliding table is first set

so that the grinding face of the dished wheel is in line with the center of the cutter. In this position the slide is fastened to the base by a thumb-screw provided for the purpose. The micrometer attachment of the stud is then operated to center a cutter vertically with the center of the wheel. The gage provided is then set into position which corresponds with the grinding edge of the wheel. The cutter being thus held, the spring tooth rest or index dog is brought up to bear on the

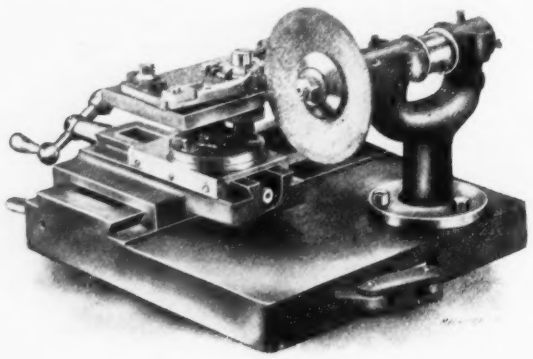


Fig. 5. The Attachment for Sharpening Gear-cutters.

back of the tooth. The grinding is done by moving the slide in and out by the crank, a couple of turns giving sufficient movement. The work is indexed by hand from tooth to tooth, backing up each time against the tooth rest.

With this convenient attachment, cutters and face and side mills up to 8 inches in diameter may be ground. For angle cutters such as shown in Fig. 4, the diameter limit is 8 inches. The gear-cutter grinding attachment will take work up to 6 inches in diameter, while reamers 8 inches in diameter and with flutes 8 inches long are within the capacity of the machine. The attachment is substantially built and firmly attached to the column of the drill grinder. The bearings, ways, and all other details of construction are carefully designed and fitted, with the idea of giving the machine a long and useful life.

VERTICAL DOUBLE SPINDLE MILLING ATTACHMENT.

The accompanying half-tone and line engravings illustrate the application, construction, and use of a new vertical double spindle attachment, which has been designed by the Kearney & Trecker Co., Milwaukee, Wis., for some special work. The manner of mounting the two heads is plainly shown in Figs.

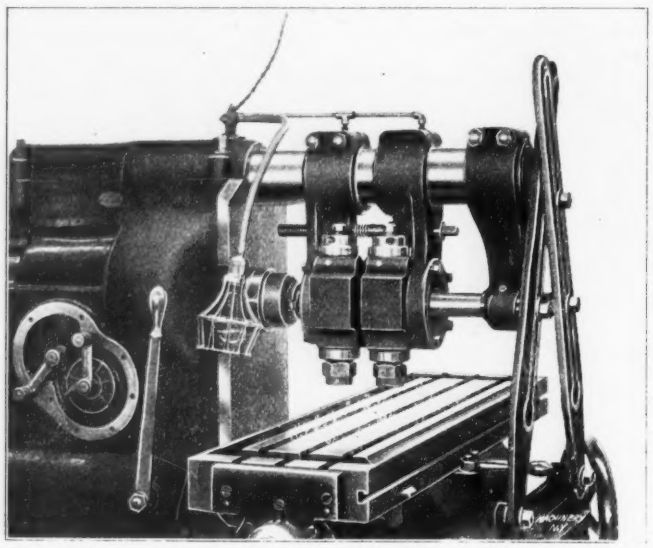


Fig. 1. Kearney & Trecker Vertical Double Spindle Milling Attachment.

1 and 2. In Fig. 2 one of the vertical heads is sectioned through the center of the vertical spindle, while a section of the other is shown through the center of the milling machine arbor. On the arbor of the milling machine are placed two spiral gears *A*, which engage with spiral gears *B* on the vertical spindles *C* of the attachment. The gears mounted on the arbor are larger in diameter than the gears on the vertical spindles, which permits the use of angles of helices more favorable for a drive of this kind than if the gears were of the same size. The angles are 54 degrees for the driver, and 36 degrees for the driven member.

An outline of the top surface of the work to be milled in this particular case is shown in Fig. 3, which also indicates the application of the mills. It is evident that in order that both cutters may run against the cut, when cutting the shoulders *E*, one must rotate in a left-hand and the other in a right-hand direction. This is taken care of by the direction of the helix in the spiral gears. The two heads can be adjusted in relation to each other by the adjusting screws shown both in

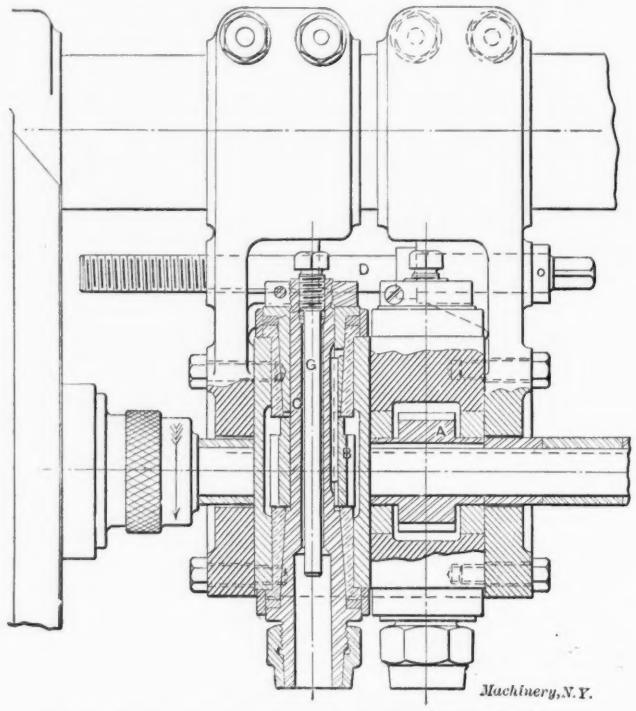


Fig. 2. Design of Vertical Double Spindle Milling Attachment.

the half-tone, Fig. 1, and in the line engraving, Fig. 2 at *D*, immediately below the overhanging arm. In the special case for which this attachment was built, it was necessary that the distance *F*, Fig. 3, should be maintained in all the pieces milled, regardless of the wear of the cutters. The adjustment between the heads was introduced for this reason, and permits a movement of one-quarter of an inch after the device has once been set up and mounted in place. Of course, a greater adjustment could be obtained by furnishing a spiral gear on the arbor which could take its end thrust against the bearings in the housing, in place of against the arbor itself, leaving the arbor without collars.

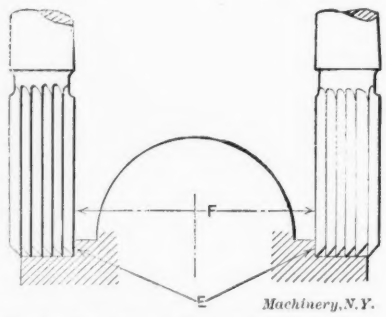


Fig. 3. Example of Use of Double Spindle Milling Attachment.

In order to make it convenient to set the spindles square with the top of the milling machine table, the casting containing the spindle bearings is made separate from the parts that are clamped to the overhanging arm. The cutters and arbors used in these spindles have straight shanks, and are backed up by screw *G* shown passing through the hollow spindle in the section in Fig. 2. This arrangement permits a slight vertical adjustment of one cutter, in order to bring both cutters to an exact level, when this is required.

MOTOR DRIVE OF THE ACME AUTOMATIC MULTIPLE SPINDLE SCREW MACHINE.

In applying the motor drive to its well-known multiple spindle automatic screw machine, the National Acme Mfg. Co. of Cleveland, Ohio, has introduced a number of improvements which tend toward a considerable increase in the effi-

ciency of the tool. These improvements include positiveness of drive, elimination of belting and counter-shaft, simplifying the setting up of the machine, and increasing the output.

As may be seen in Figs. 1 and 2, the driving motor is mounted on a bracket at the rear of the machine. Its armature shaft carries a pinion which meshes with a large gear on the driving shaft of the machine, taking the place of the

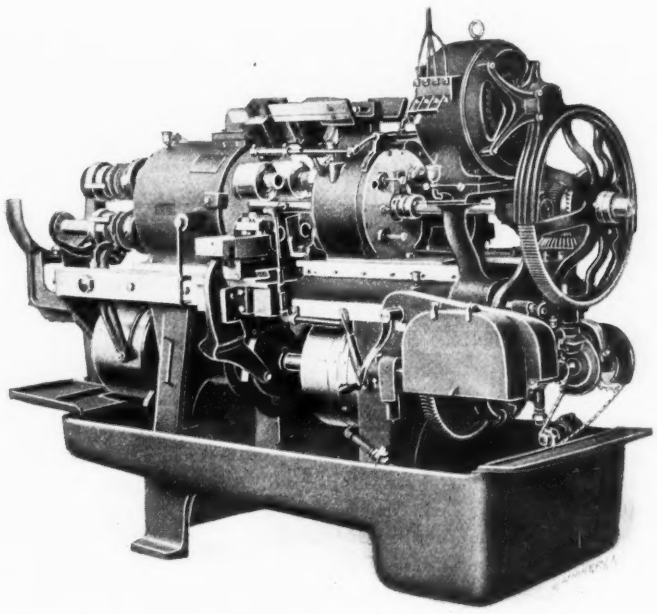


Fig. 1. The Acme Automatic Screw Machine arranged for Motor Drive.

driving pulley furnished with the belt-driven styles. In Fig. 2 will be seen gearing which furnishes a back gear connection between the driving gear and the shaft on which it is mounted, so that either of two rates of speed may be used.

The driving gear is connected with a short horizontal shaft at the base of the machine by the vertical shaft and bevel gears shown. The oil pump is driven from this shaft by a chain and sprocket wheel connection; since the driving gear always runs when the spindles are revolving, a supply of oil

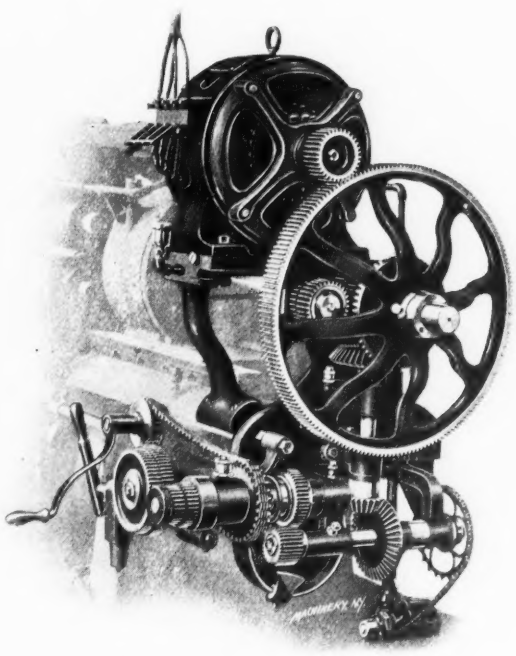


Fig. 2. Arrangement of the Driving Gears.

to the work is assured under all conditions when it is possible for cutting operations to take place. In this respect it is far superior to the usual belt-driven pump, in which the breakage or slipping of the belt means disaster to the cutting edges of the tools. A clutch, operated by a convenient handle, is provided for changing the speed of the cam-shaft from fast to slow. The crank shown is attached to the worm-shaft driving the cam mechanism, the power feed being operated by a chain of the silent type, leading to clutch. Change gears are provided for altering the rate of revolution of the cam-shaft and the consequent rate of production of the machine.

It will be seen that when the clutch is in the central position, the sprocket wheel driving the cam mechanism is entirely free on its shaft, so that the hand operation by means of the crank is rendered very easy, the entire transmission mechanism being entirely out of operation. The clutch lever may also be used for operating the tools intermittently in setting up or in testing. The same mechanism is used for the single belt drive, the large driving gear being replaced by a pulley which, if desired, may be directly connected with the clutch pulley on the line shaft, the counter-shaft being then unnecessary. In the motor-driven machine, any standard motor may be used without alteration, the size being properly selected for the size of the machine used, ranging from 3 to 5 horse-power. The machine shown is the builder's No. 56 size, arranged as exhibited at the Atlantic City convention of the Master Mechanics' Association.

CHAMBERSBURG LINE OF STEAM DROP HAMMERS.

The Chambersburg Engineering Co., Chambersburg, Pa., a firm which has had wide experience in building steam hammers, was the pioneer in the development of this machine as specialized for drop forging. The employment of the steam drop hammer for this work was necessitated by the increased use of large drop forgings for parts formerly made of malleable iron, or steel castings. The first of these machines put on the market for this purpose, were capable of doing larger and better work than the previously used board drop hammers, and were less expensive to maintain. Like all new machines, however, a number of weaknesses developed in the severe service to which they were put. The builders have carefully corrected these weaknesses as fast as they have appeared, and have now developed a line of drop hammers that have proved to be thoroughly satisfactory in the service exacted of them.

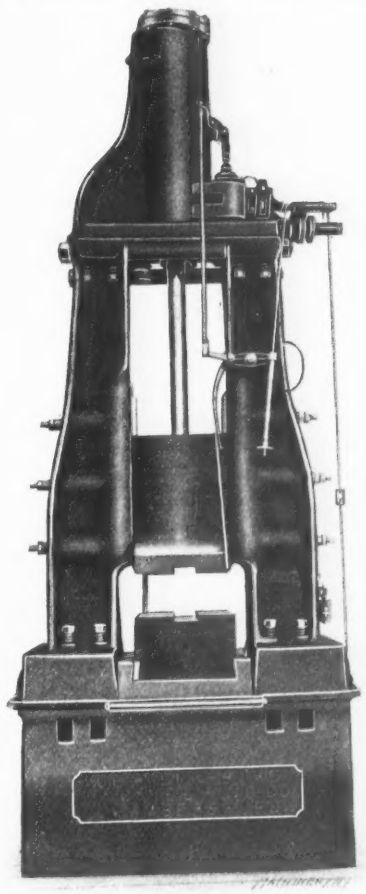


Fig. 1. The Standard Chambersburg Steam Drop Hammer for Drop Forging and Similar Work.

The standard form of the Chambersburg steam drop hammer is shown in Fig. 1. A special feature of the construction is the form of tie-plate used, which is provided with ledges or lips fitting around the top of the frames and around the face of the cylinder, thus taking the strain off the bolts and holding the upper members of the hammer in line. The anvil also lips the frame on four sides, relieving the anvil bolts and preventing the shifting of the frames on the anvil. This arrangement makes the hammer very rigid and keeps it in permanent alignment—an important consideration in producing first-class forgings. The hammers are quick acting, re-

quire but little attention, and are always under the control of the operator. The frames and anvils are made of air furnace iron, except where extra hard service is required of the machine, in which case steel castings are used. The hammer shown in Fig. 1 has steel side frames and a cast iron anvil.

In addition to this standard design, the firm has built a slightly modified style, of which an example is shown in the 6,000-pound drop hammer in Fig. 2, built for the Bethlehem

Fig. 2. Special Form of Drop Hammer furnished to the Bethlehem Steel Co.

Steel Co. The special feature of this design is the method of aligning the dies, by adjusting the frames on the anvil, instead of employing the usual taper gibs in the die-block and ram. These hammers have cast steel anvils and frames, and have been successfully used on the heaviest kind of drop forging work.

ARMSTRONG SHORT RATCHET DRILL.

A new ratchet drill of a design which differs from those in common use has been brought out by the Armstrong Bros. Tool Co., 113 N. Francisco Ave., Chicago, Ill. The principal feature of

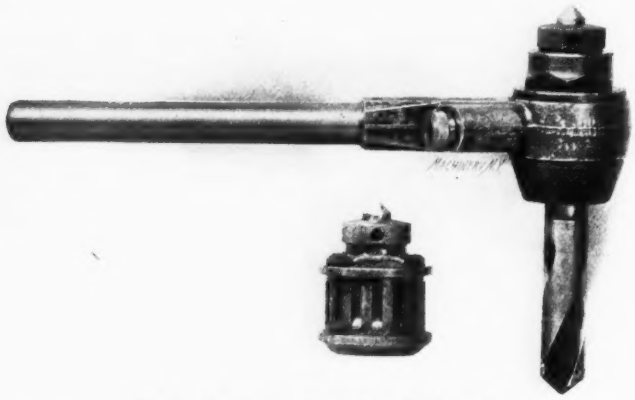


Fig. 1. Armstrong Short Head Ratchet Drill.

this appliance, designated by the makers as the Armstrong short ratchet drill No. 2, is that the mechanism for feeding has been designed in such a manner as to make the head of the tool shorter and more compact than usual. How this has been accomplished can most easily be seen from the line engraving, which shows at the left a section through the head of the type furnished for taking drills with No. 3 Morse taper shanks, and at the right, a type intended for square taper shanks. This latter construction gives a head shorter than that of any ratchet drill made, length of feed considered.

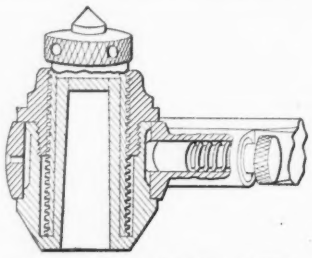


Fig. 2. Head for No. 3 Morse Taper Shanks. Length, 3 3-4 inches; Feed, 2 3-4 inches.

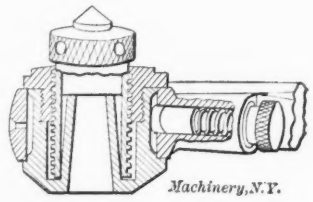
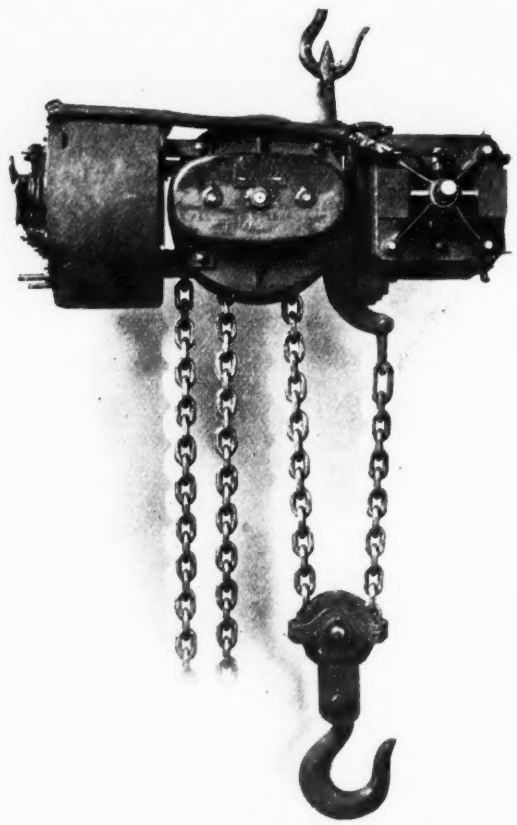


Fig. 3. Head for Square Taper Shanks. Length, 2 3-4 inches; Feed, 1 1-2 inch.

There are no castings used in the construction of these drills, all parts being made either from drop forgings or from bar steel, the pawl and center being of tool steel, hardened.

NORTHERN ELECTRIC CHAIN BLOCK.

A new electric chain block has been brought out by the Northern Engineering Works, 26 Chene St., Detroit, Michigan. This hoist is designed to supplant the ordinary hand chain block, suspended by a single hook. It is known as the Northern C type electric chain block, and is a modification of the original C type placed on the market three years ago. The present design embodies several improvements over the old one, one of the advantages obtained being a shorter space between the hooks, insuring higher lifts under low ceilings.



Northern Engineering Works C Type Electric Chain Hoist.

Referring to the half-tone illustration, it will be seen that the hoist is of the same general design as the hand chain blocks, excepting that it is driven by a crane motor with a standard crane controller having ample resistance. The block can be operated at several different speeds, and it is possible to obtain a speed ten times faster than that obtainable by hand-power. At the same time a hoist of a given capacity is of about double the size and strength that it would be if designed for hand-power. This larger factor of safety is used on account of the more severe service to which the electrically-driven block will be subjected. Worm gearing, bevel gears, and planetary gear combinations have been avoided in the design of the hoist, and spur gears cut from solid steel blanks are used throughout. This increases the life of the block, and

decreases the amount of repairs necessary. All gearing is properly covered, and the principal gears run in oil.

As compared with the ordinary drum hoist, a block of this design has the advantage of suspension by a single hook, and tipping or getting out of line will not force the sprocket chain out of the sprocket groove, as would be the case with a wire rope on a drum. The hoist can also be swung sideways without meeting with this difficulty.

Motors of any standard make can be used, and will be furnished for either direct or alternating current. The sizes range from 1 to 6 tons capacity, and the hoists are intended primarily for moderate service, especially over tools in boiler shops and machine shops, in warehouse service, and in some kinds of foundry service.

MILWAUKEE 16-INCH LATHE.

The lathe shown herewith, built by the Milwaukee Machine Tool Co., Milwaukee, Wis., is designed to meet the requirements of manufacturers in need of a high-grade tool of simple construction, combining durability, power, and high cutting capacity. It is at present built only in the 16-inch size, which can be furnished in any length of bed desired from 6 to 16 feet. The head- and tail-stock are strongly made, fitted to a V bearing at the rear and a flat bearing at the front. The head-stock has two large oil reservoirs located beneath the spindle,

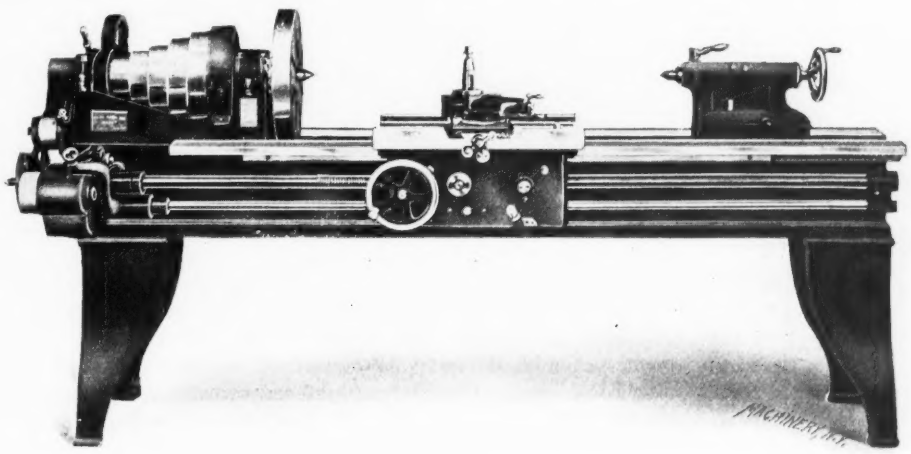


Fig. 1. The Milwaukee 16-inch Lathe.

supplying oil to the bearings by a wick. The tail-stock is so designed as to leave ample clearance for the compound rest when the latter is used for angular cuts. The carriage is fitted to the V's at both front and rear. The apron has a

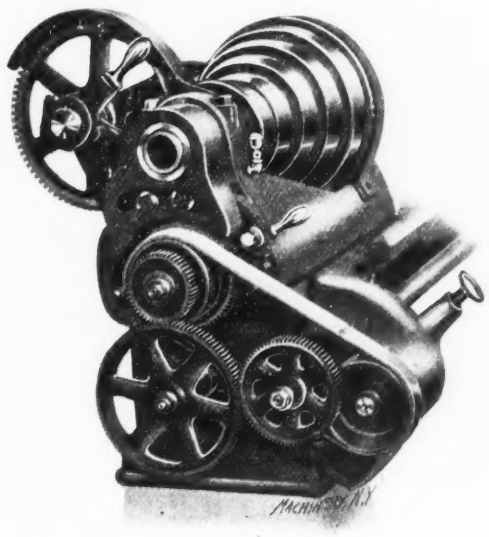


Fig. 2. End View of Head-stock.

clutch for engaging the longitudinal feed, and a sliding gear for the cross feed. The feeds are reversed in the apron, and a safety lock is provided for the split nut. Special care has been taken in the design to place all the handles so as to be most convenient to the operator.

A feed box giving four quick changes is provided, driven from the spindle by a wide belt furnished with a belt tightener conveniently located. The change gearing may be used to provide an additional feed when a coarse, positive roughing cut is required. For thread cutting, the different pitches are obtained by change gears in the usual way. The following dimensions will give some idea of the proportions of the design. The main spindle bearings are of phosphor bronze, the one at the head end being 3 3/16 inches in diameter by 5 inches long. The spindle has a 1 9/16-inch hole through it from end to end, and is made of high carbon crucible steel, cut from the solid, and accurately ground. The cone pulley takes a 2¼-inch belt, and is 11 inches in diameter on the largest step. All the important pinions and gears are of steel, cut from the solid. The net weight of the machine with an 8-foot bed is approximately 2,500 pounds, complete. The equipment regularly furnished includes a counter-shaft, compound rest, steady rest, follower rest, large and small face-plates, and all the necessary change gears and wrenches.

SCHELLENBACH 16-INCH GEARED HEAD LATHE.

The John B. Morris Foundry Co., 933 Harriet St., Cincinnati, Ohio, has placed on the market an engine lathe involving so many original and ingenious features that it is difficult to know where to begin in describing it. The main purpose of the design was to build a lathe adapted to the use of high speed steels to their full capacity, on work of all diameters from the smallest to the full swing of the lathe, and still preserve all the quickness and convenience of operation found in the usual engine lathe. In the actual working out of the design, however, not only has the convenience of the standard engine lathe been retained, but this new machine "goes it one better" even, being built on lines so original that little of standard lathe design is in evidence. Among the features of the tool, should be mentioned the Schellenbach taper attachment, the provision for using the rack in roughing threads, to save the lead-screw from wear, a support for the carriage, directly beneath the work, provision for sixteen changes of speed in the head-stock, and the use of a face-plate drive for both chuck and face-plate work of large diameters. It would be impossible to go thoroughly into the details of the machine within any reasonable space, but the description we give herewith, with the illustrations, will serve to give a general idea of the construction of the lathe and the advantages which it is intended to furnish.

The Head-stock and Spindle Gearing.

As has been stated, the head-stock gearing gives sixteen changes of speed from a single speed driving pulley, loosely mounted on the spindle. One of these drives is direct, the pulley being clutched to the spindle for the purpose. Seven of the speeds are obtained by gearing applied to the spindle, while the eight slower ones drive the face-plate through a pinion meshing with the internal teeth cut in its rim. An index combined with the mechanism for changing the head-stock gearing shows the operator the diameters for which the spindle speed he is using is suitable, for various cutting speeds ranging from 20 to 60 feet per minute. The operator need not know the number of revolutions per minute of the spindle, as he can thus deal directly with the diameter of the work in hand and the cutting speed in feet per minute desired. The various movements of the sliding gears in the head are so interlocked as to make it impossible to engage them wrongly, so that making changes can be done quickly without fear of a false move.

Provision is made for motor drive in the original design of the machine. Cored openings are made through the head-stock, so that a motor may be attached beneath the bed and

connected directly by a belt or chain with the driving pulley of the spindle, or with a sprocket similarly placed. Where it is desired to mount the motor above the head-stock and connect it by gearing with the spindle, the hinged cover provided for the change gear mechanism is cast with a motor base, making but a very slight alteration in the design of the machine. Owing to the great number and range of the speed changes in the head-stock, a constant speed motor may be used for driving, no electrical changes of speed being required. The maximum increment of speed in the mechanical changes is only 28 per cent in two successive steps.

The face gear is of steel, and is secured to a flange on the spindle on the outside of the front bearing. It extends out through the head-stock and is threaded to receive the face-plates or chucks. Since the driving pinion is placed on the front side, it is properly located to resist the action of the cut without causing undue strain on the top cap of the front spindle bearing. The spindle itself is of forged crucible steel, bored throughout its length, and ground true. The head-stock casting is of box construction, with the sides extending above the center of the spindle, tying the front and back bearing together to resist end thrust. Excepting for the opening for the driving pulley, it is entirely enclosed, though the interior is rendered accessible by releasing a single screw and throwing back the hinged cover mentioned.

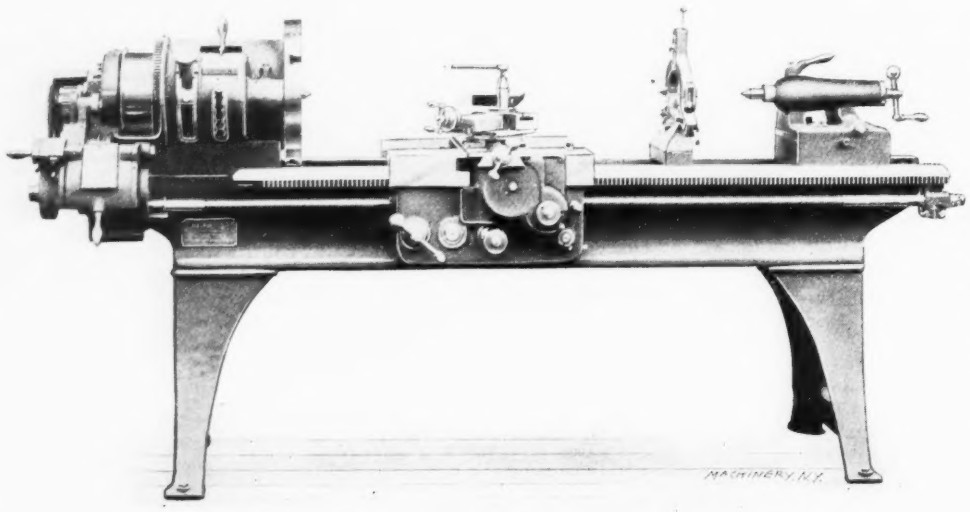


Fig. 1. Schellenbach Geared Head and Feed 16-inch Lathe.

Feed Change Mechanism.

The form of quick change gear device used is one that is entirely novel, so far as we are aware. The handle seen projecting from the change gear casing is not used in shifting the gears, as might be imagined, but is simply employed for raising the lid of a receptacle in which loose change gears are placed. The one of these gears desired is slipped by hand on a stud, which is thrown into engagement with that one of three intermediate gears, which is at the time set to engage it. As there are eight change gears, this gives 24 feeds or pitches of thread. A second change is provided which doubles this number, making 48 changes in all, ranging from 2 to 112 turns per inch. The connections are such that the threading, turning, and facing movements are all at the same rate, so that one dial reading may be used for all three. It is the belief of the designers of this machine that this quick change device combines all the simplicity and directness of drive of the old style of change gearing with the ease of operation of the later forms of quick change mechanism. The steel gears used are slipped on by hand and do not require to be held by a nut, cotter pin or other device. Power is transmitted from the spindle to the screw in as direct a manner as in the regular form of engine lathe, and there is no complicated mechanism to be damaged by accident or wear out in use.

The Carriage, Tail-stock, and Bed.

The design of the bed may be best understood by reference to Figs. 2 and 3, in which the arrangement of the ways and the bearing of the carriage and tail-stock on them is plainly shown. The carriage is very deep and strongly ribbed to resist the torsional and direct stress produced by the cutting action. The legs are set well in to give better support, and are of wide span. The carriage runs on a V at the front side of the bed and a flat bearing at the rear, and is also supported on a central sliding surface to which it is held by gib *A* and strap *B*. It has often been customary to give the carriage an inner bearing on the flat ways which serve also for guiding the tail-stock, but this has the disadvantage that the wear produced by this carriage bearing disturbs the vertical alignment of the tail-stock spindle. This supplementary bearing at *A*, it will be seen, gives the carriage strength where it is most needed, providing, in combination with the regular bearings, a firm support to the tool, whether it is working on large or small diameters.

The tail-stock also slides on a V at the front side of the bed, and on a flat bearing at the rear. Not only is this arrangement of the ways the simplest for obtaining a good fit, but it is the most durable as well. The tail-stock is clamped from the front side by screw *C*, which bears against the point of clamping lever *D*, pivoted at *F* and provided with a short lever arm which engages the under side of the ledge in which strap *B*, in Fig. 2, takes its bearing. The bearing points in this arrangement are made of tool steel. It will be seen that a very slight pressure exerted against screw *C* will cause the clamp to bear very tightly under the shear of the lathe bed. The side adjustment of the tail-stock can be effected independently of the clamping of the base to the bed, an arrangement met with on many larger lathes to insure against slipping back when setting tapers for heavy work. All the adjusting screws of the tail-stock, and every other adjusting screw in the lathe, for that matter, can be operated with the tool-post wrench.

Apron and Cross Slide Mechanism.

As shown at *E* in Fig. 2, the rack is set with the teeth on the vertical face instead of on the under surface as usual.

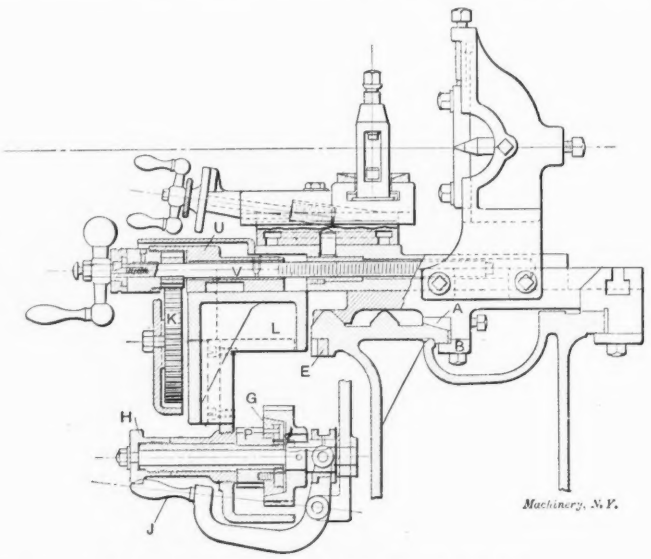


Fig. 2. Section of the Apron, Carriage, and Bed.

This permits setting the pinion shaft in a vertical position, so that it has a bearing in the apron on each side of the pinion, making a very strong and durable mounting. The rack and pinion feed is driven from the spline of the lead-screw through bevel and spur gearing, connected by the friction *G*, operated by knob *H* in the usual manner. The ratio of this connection is such as to give the same travel per revolution for the lead-

screw as is given the carriage when the split nut *H* in Fig. 3 is thrown into action. The rack is cut with such accuracy that it may be used with confidence by the operator for rough threading, to within a few thousandths of the finished size, using the lead-screw only for the fine finishing chips, thus greatly prolonging its useful life. In this use of the rack and pinion in threading, a positive connection is engaged in place of friction *G*, shown in Fig. 2. This positive connection is operated by lever *J*. The split nut does not require a locking device to prevent its engagement at the same time with the friction feed, since both give the same movement and both may be thrown in together without damage of any kind. The upper end of the pinion shaft projects through the top of the carriage and is provided with a dial graduated to read to 64ths of an inch.

The power cross feed is transmitted from the apron gearing to the cross feed screw through an intermediate gear *K*, shown in Fig. 2. The movement given this screw, as has been explained, is the same as that given the carriage by the lead-screw or the rack - and - pinion feed, so that the table of feeds and threads serves for facing and scroll cutting as well as for the longitudinal movements. The compound rest slide is tipped up slightly, as shown in Fig. 2. This brings the handle sufficiently high to avoid interference with the cross feed screw, at the same time allowing the rest to be made very low and rigid. The top slide is offset to clear the tail-stock when set at or near 90 degrees. Its feed screw, as well as that for the main cross slide, is provided with a graduated collar reading to thousandths of an inch.

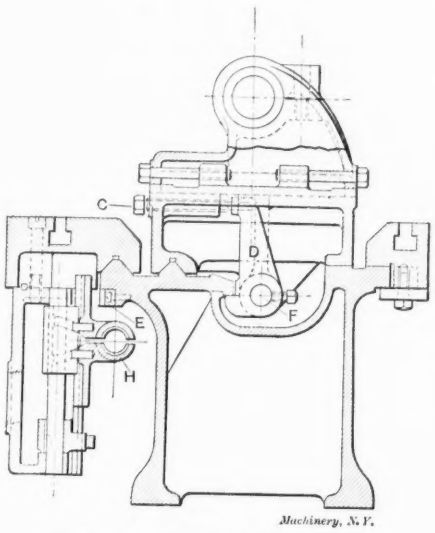


Fig. 3. The Tail-stock and the Method of Clamping it.

The apron is tongued, grooved and bolted to the carriage. All the handles and levers are placed in convenient position and about the same location as found in the conventional apron. Owing to the position of the legs at the end of the bed, and to the fact that the split nut is placed at the left side, it is possible to run the carriage to the extreme end of the bed, where the mechanism is exposed for examination without removing the apron.

The Taper Attachment.

The most radical departure in construction from the conventional lathe design relates to the form of taper attachment

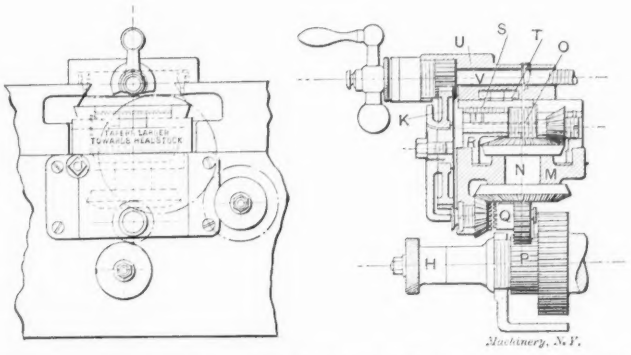


Fig. 4. An Ingenious Taper Attachment operated by the Apron Gearing.

used. A "dummy casting" *L*, Fig. 2, is removed and in its place may be inserted the casting holding the mechanism comprising the taper attachment, shown in *M* in Fig. 4. This casting carries the double vertical bevel gear *N*, meshing at the upper end with a bevel pinion, driving screw *O*. The lower gear of double gear *N* is driven from pinion *P* on the friction, through clutch *Q*, which may thus be operated to engage or disengage screw *O* from positive connection with the rack and pinion feed of the carriage. Screw *O* is carried on a pivot in swivel block *R*, which may be adjusted about the axis of *N*. *R* carries a guide on its upper surface in which slides the bronze half nut *S*, engaging screw *O*. To *S* is pivoted the block

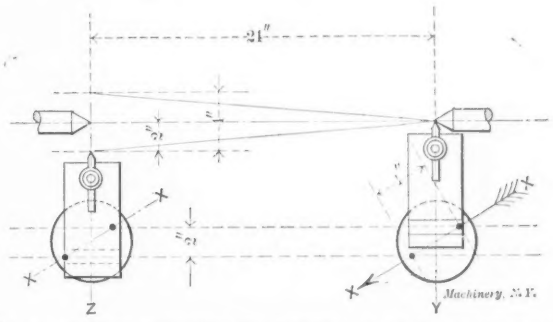


Fig. 5. Diagram illustrating the Principle of the Taper Attachment.

T, which is seated in a cross groove in the base of cross slide screw carrier *U*, which is in turn dove-tailed into the same ways in which the cross slide is dove-tailed.

With mechanism arranged in this way, it will be seen that when (by the operation of the power feed or the apron hand-wheel) the carriage is traversed by the rack and pinion movement, a corresponding movement through the train of gears just described is imparted to nut *S* and block *T* by the rotation of screw *O*. If the angular adjustment of *R* is set so that the axis of *O* is parallel with cross slide, screw *O* will transmit all of this longitudinal movement to holder *U* and cross slide screw *V*, which will thus be moved axially. If, on the other hand, *R* is adjusted through an angle of 90

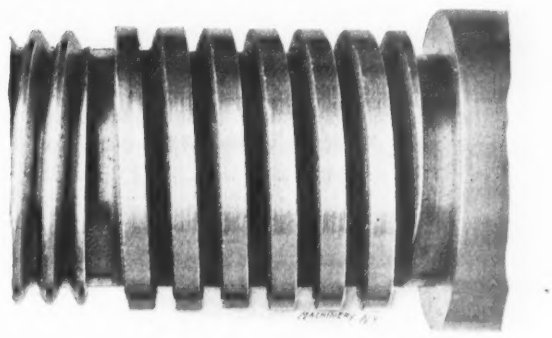


Fig. 6. A Square Thread roughed with the Rack Feed and partly finished with the Lead-screw.

degrees so that the axis of *O* is parallel with the center line of the lathe, the half nut *S* and block *T* will have a movement in the same direction, the latter sliding freely in the groove in *U* without imparting motion to it. In any intermediate position within these two a greater or less movement will be imparted to *U* for a given travel of the carriage, depending on the sine of the angle at which *R* is set. In a travel of 24 inches, with block *R* set as shown at the right of Fig. 4, the full travel of block *U*, 4 inches, is obtained. This gives a taper of 8 inches in 24 inches, or 4 inches to the foot, the maximum for which the attachment is adapted.

In Fig. 5 is a diagram showing the action of the device when set at an intermediate position between two extremes. As shown, in traveling from position *Y* to position *Z*, a distance of 24 inches, nut *S* and block *T* in Fig. 4 have a movement of 4 inches on axis *X X*. This, with the angular setting given, results in a cross movement of the cross feed screw of 2 inches, giving a taper of 4 inches in 24 inches, or 2 inches per foot. For tapers smaller toward the head-stock, block *R* is adjusted around the other side of the zero point, graduation being provided for the setting as shown at the left in Fig. 4.

Before the pin which engages clutch *Q* can be operated, the casing holding gear *K* has to be removed. This disconnects the power cross feed mechanism, which is, of course, never used at the same time as the taper attachment. When the taper attachment is in use slide *U* also has to be loosened, it

being located firmly in place in the top of the carriage for ordinary straight turning. The mounting of the taper turning device on the apron instead of at the back of the machine, is a great convenience.

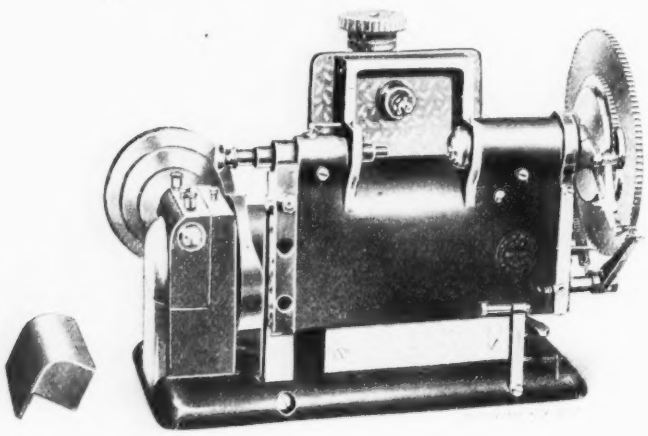
Accessories.

The follow rest provided straddles the tool slide, being clamped to the carriage on each side, furnishing a firm, steady support to the work. It has three jaws. The back rest is separate from the base by which it is attached to the ways, and may be reversed on that base so as to face either way. This provision overcomes the difficulty ordinarily met with in the usual construction where the V and a flat way are used for supporting it, in which case the steady rest is ordinarily irreversible. The counter-shaft provided is operated by two friction pulleys. Where it is not thought necessary to drive in both directions, two forward speeds may be used, thus giving 32 changes to the head-stock spindle instead of the 16 provided by the head-stock gearing with the single speed counter-shaft. This machine is manufactured at the present time in 14-, 16- and 18-inch sizes, and may also be supplied with the 3-step cone type of head as well as in the style here illustrated. It is also made with plain change gears in place of the quick change devices we have described.

A number of samples of work done on this machine have been sent us, all of them interesting, of which we have room for but one. This (see Fig. 6) illustrates the use of the machine in roughing threads with a rack feed and finishing them with a screw feed. As will be seen, a roughing cut has been taken in the square threads shown, followed by a finishing chip which has been carried to but half the depth, showing both cuts plainly. This is an operation that may be followed on threads of fine pitch, great care having been taken in the cutting of the rack to make it match the lead-screw accurately.

WALTHAM AUTOMATIC PRECISION GEAR-CUTTING MACHINE.

We show herewith an illustration of a precision gear-cutting machine recently designed by the Waltham Machine Works, Newton St., Waltham, Mass. Like other machines for precision work the movements are cam operated, from a shaft driven through worm gearing by the grooved cone pulley shown at the left. This worm gearing is enclosed and runs in oil, but can be removed without disturbing other parts of the machine. The movements effected by the cams on this shaft are the feeding of the work past the cutter; separating the cutter and the work for the return stroke, and indexing. The latter movement takes place while the work is being returned, thus making a considerable saving of time over those machines in which the cutter travels back in the tooth cut, and has to be held clear of the work longitudinally before the indexing can be effected. The index disk is proportionally of large diameter (10 inches), and is arranged to cut from 12 to 240 teeth.



Precision Machine for Cutting Clock and Instrument Gears, etc.

A noticeable feature of the machine is the complete protection afforded to the index plate, cams, and other working parts, from the chips produced by the cutting operation. These are very troublesome, especially if the work is of brass or some similar material. As may be seen, the head- and foot-stock spindle project through two side plates in the work slide, which are so arranged that a cover with a scraped fit may be brought down over them, entirely enclosing the cutter and work, and forcing the chips to drop directly down in front of the machine instead of flying all over the mechanism.

If desired, the machine may be arranged for going twice around the work, taking two cuts through each space, automatically shifting to a slightly deeper cut the second time around.

The capacity of the machine is for gears up to 3 inches in diameter when the chip protection is used; for cutting iron and steel without the protection, blanks 4 inches in diameter may be handled. The machine may be furnished with a heavier spindle if required, in which case gears as coarse as 24-pitch may be cut. The construction of the machine is in line with that of the automatic watch machinery built by the same firm, being provided with hardened steel pinions and other working parts, and finished with the utmost accuracy.

ROCKFORD MACHINE & SHUTTLE CO.'S SENSITIVE DRILL.

The Rockford Machine & Shuttle Co. of Rockford, Ill., is building the sensitive drill press shown in the accompanying illustrations. The construction is simple and rigid, and a number of new features are provided in the accessories furnished with the tool.

Fig. 1. Drill arranged to use Tilting Square Table.

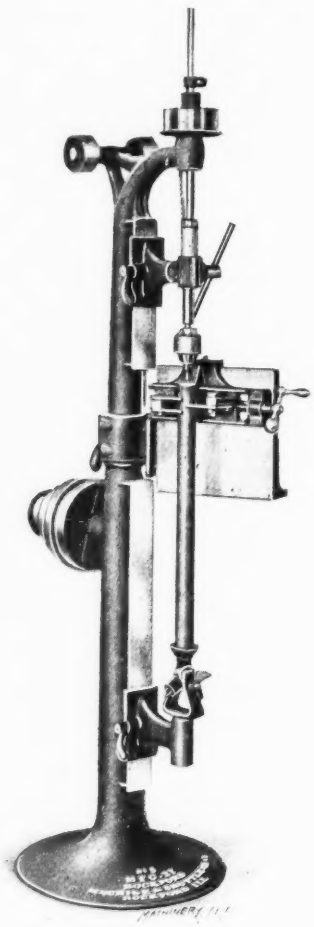


Fig. 2. The Centering Attachment in use.

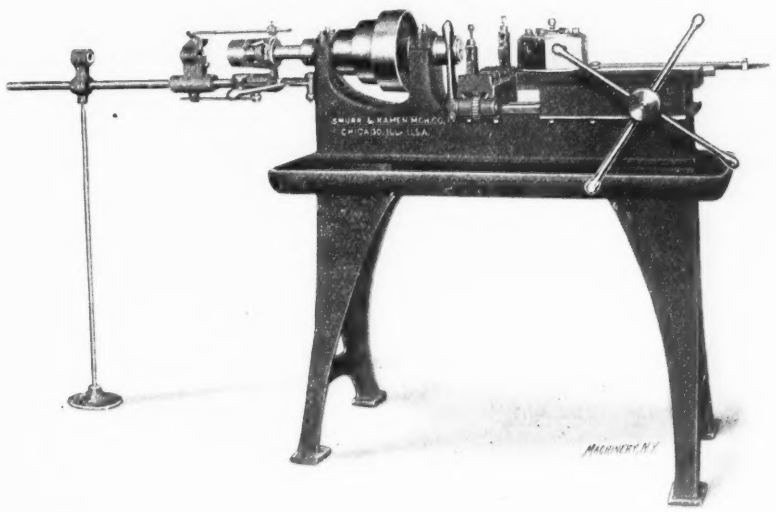
As will be seen in Fig. 1, the regular table provided can be tilted to any angle for work that requires holes to be drilled out of the perpendicular. A squared straight-edge is provided for lining up work. This may be conveniently used as a V-block for round parts. One edge of the table is widened to provide a clamping surface for work which is more conveniently held at the side than on the top of the table. On ways at the bottom of the column is fitted an arm carrying a circular table, as shown in Fig. 1, which may be used for holding work when the upper table is swung around out of the way.

This table revolves on a stem in the arm, and may be removed and replaced with the combination center vise shown in place in Fig. 2. This, it will be seen, contains three forms of centers: a cup center, a pointed center, and a V center. The cup center is shown in use.

In Fig. 2 the upper table has been tipped into a vertical position and has a centering vise clamped to its face. A piece of stock is being centered with a combination center drill. The vise is located in line with the spindle of the machine by a taper pin which fixes the swinging arm of the table in proper relation to the spindle. The lower end of the work is being held on the cup center as shown. This makes an arrangement fully as easy to operate as the usual horizontal centering machine, for stock which is not too long to be outside the range of the machine

SMURR & KAMEN PLAIN HEAD SCREW MACHINE.

The Smurr & Kamen Machine Co., 97-101 S. Clinton St., Chicago, Ill., has been for some time building a plain screw machine which it has been trying out in actual use in the shops of customers, to determine its durability and efficiency. The results of the use of these machines have been so satisfactory that it has been determined to place them actively on the market, where it is believed that the simplicity and effectiveness of their design and the accuracy of their construction will give them a permanent standing.



The Smurr & Kamen Plain Head Screw Machine.

The feature of prime importance in getting good results from a screw machine is the accurate alignment of the center of the spindle with the center of the turret holes, and the maintenance of this alignment throughout the life of the tool. This prime feature is taken care of in the machine shown herewith by providing such sliding surfaces and gibs that the turret can be adjusted either vertically or sidewise to bring the holes back into alignment with the spindle as soon as they are thrown out of position by wear. The vertical movement is taken care of by a taper gib placed between the turret slide saddle and the bed of the machine. The adjustment of this gib alters the vertical position of the turret to allow for the wearing away of the bearing of the turret on its seat. This wear is much more rapid than that of the spindle in the box, thus necessitating occasional re-alignment. The turret slide is gibbed to the turret slide bed by taper gibs instead of by a more common and less expensive plain strip adjusted by set-screws. The bearing obtained with a taper gib is much more satisfactory, extending the full length of the slide instead of being concentrated around the points of the set-screws.

The turret is hexagonal in shape, so that heavy tools can be fastened to the face, giving better support than when the shank only is used for holding them. Instead of the usual hand lever for clamping the turret after the indexing, an ingenious arrangement is provided by means of which this clamping is effected automatically by the action of the pilot wheel which operates the slide. This is a most satisfactory arrangement, greatly enhancing the accuracy and the usefulness of the tool, since, with the usual construction, the workman is free to clamp the turret or not, as he pleases, and he often neglects to do so. As this arrangement does away with the necessity for the usual stud for clamping, it is possible to feed stock clear through the turret, or to use drills with shanks of indefinite length. The standard automatic indexing mechanism is used for the turret. A large index ring and a lock bolt of the horizontal type are employed. The latter is supported on either side by steel taper gibs, by the adjustment of which it is possible to maintain the parallel alignment before referred to for lining up the center of the spindle.

The wire feed is of a new design developed by the builders. It is continuous in its action to the full length of the bar used, it being unnecessary for the operator to stop his work to push a sliding head or clamp collar back for a new grip on the stock. The counter-shaft provided has two friction clutches for reverse motion. Special attention has been given to the design of these clutches, which are provided with unusually large area of gripping surface. In the case, for instance, of the machine shown, the friction face is 9½ inches diameter and 1¼ inch wide.

It will be seen that nothing startling or revolutionary has been undertaken in the design or construction of these machines. The plan of the builders was to follow lines which, while original, were not so radical as to be of doubtful usefulness, but every effort was made to provide the user with a tool that would not require rebuilding at the close of every busy season. The best of material is used, all the duplicate parts being made with jigs and fixtures on the interchangeable plan, and full use being made of accurate surface plates, straight-edges and test indicators in measuring and testing the separate parts and the finished machine. These provisions, with the means furnished for preserving the vital alignment of the turret holes and the spindle, should make it a most accurate and durable machine.

This screw machine is made in five different sizes, ranging from 10 inches to 18 inches swing over the bed, and with a maximum automatic chuck capacity of from 2 to 2¾ inches.

EASTMAN KODAK CO., Rochester, N. Y. Copying camera for making copies of drawings, tracings, etc., on bromide paper without the use of a negative.

BOSTON TOOL CO., 207 Bridge St., Cambridge, Mass. A new threading tool which is said to greatly reduce the time required for threading, especially on such difficult material as cold rolled steel. The tool straddles one thread and cuts the adjacent faces of the two threads on either side. Since but one face of the thread is cut at a time, the chips are free to roll away from the work, and very heavy cuts may be taken. The device is made in the shape of a circular forming tool held in a suitable holder, or, as a plain straight face forming tool. A special cutter is required for each pitch.

WHITNEY MFG. CO., Hartford, Conn. Chain belt and adjustable pulley for high speed and light, noiseless service. The chain is composed of center blocks, rivets and special side links. A piece of formed leather is wrapped around each pair of side links and is held in place by a steel link on the top surface. The chain belt thus made runs over grooved pulleys, and nothing but the leather comes in contact with these pulleys, making the belt noiseless at the highest speeds. The chain center gives great flexibility even when running over the small pulleys, and prevents the belt from stretching. The flanges of one of the pair of pulleys are made adjustable to keep the proper tension on the belt.

AN AMERICAN MECHANIC IN EUROPE—3.

THE THIRD OF A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

TURIN, ITALY, May 14, 1908.

Trade Conditions in Austria.

The machine industry in Austria has, generally speaking, not suffered very much from the general depression. The machine export business of Austria is mostly confined to Hungary, Turkey, and to the smaller states on the Balkan Peninsula. The exports to the larger industrial countries in Western Europe are small, and, therefore, a depression in these countries is not felt to any large extent in Austria. Aside from this, many of the machine shops, especially those devoted to railway equipment, are engaged in filling orders for the Austrian State railways, and this does, of course, influence the machine building trade throughout the country.

Present Industrial Conditions in Italy.

A depression in the industries in Italy is plainly in evidence, and in addition to the general business depression experienced everywhere, the dullness in Italian business has also a local cause. A short time ago the automobile industry in this country passed through a severe crisis, and several firms failed. As this industry is one of the largest of the machine industries in Italy, the machine tool business suffered to a great extent because of the loss of one of its best customers, and many of the leading machine tool dealers report a drop in business of from 20 to 80 per cent, mostly in machine tools, and to a smaller extent in small tools. In spite of this, however, the present sentiment seems to be optimistic. The automobile trade, according to reports from various factories, is improving, and one concern, Fabbrica Automobili Itala, Turin, is now working full time with full force. It is also stated that the shops devoted to railway equipment have on hand large orders from the Italian Government. Since the railways passed into the hands of the government in 1905, many long-needed improvements in the rolling stock have been undertaken, or are under way, and this means more work for the machine shops. The railway equipment shops need more tools for executing their orders, but they are postponing the buying, expecting prices to go down.

The Machine Tool Market in Italy.

The Italian machine tool industry does not as yet amount to very much. There are only a few small factories for machine tools, but judging from the extensions being completed for these factories, Italy may soon produce a large part of the machine tools for its own use. At present, however, machine tools from nearly all countries—America, Germany, England, Sweden, etc.—are sold and used. As there is but little chance to talk about favoring a home industry in this case, both dealers and users are able to judge and compare the different makes of machine tools in a fairer manner and with less prejudice. The prevailing opinion is that American machine tools are, in general, better than the makes of any other country, but this does not mean that there are not some German makes considered superior to some American. It is considered here that the superiority of the American machines lies principally in the design, which is to the credit of the American draftsman, but also, although in a smaller degree, in the workmanship.

The claim that American machines are not strong enough, which is so often heard in Germany, both from dealers and users, is not mentioned here so much; in fact, only two persons out of a dozen whom the writer has interviewed on this subject, had anything to say to this effect, and one of these persons, a manufacturer, admitted that it was common practice here to use the machines for much heavier work than they were ever intended and built for. An interesting fact, needing no comments, is that in the automobile shops visited by the writer, he found that the large majority of machines used were of American make, and only a few of German and English manufacture.

It may not be out of place to mention that although the workmanship of American machines is good in general, there are sometimes found deplorable examples of carelessness of inspection in some of the machines of American manufacture. A few days ago the writer, when calling on a machinery dealer, saw a machine of American make which this dealer had sold and delivered, but which afterward had been returned, because of not being satisfactory, there being blow-holes in the castings in places where such could not be tolerated, and several other defects. It must be added, however, that the dealer himself was very much surprised, and said that it was the first trouble of the kind that he had met with. The only reason for mentioning this is to suggest that too much attention cannot be paid to thorough inspection of machine tools before being sent abroad, in order to prevent occurrences of this kind, which, while everybody over here acquainted with American machine tools knows to be exceptional, still will prove harmful.

"Talking Points" in Selling Machine Tools.

The ease with which a machine can be sold depends, of course, in the first place upon the real merits of the machine, that is, on the amount and on the kind of work the machine is able to do; but so-called "talking points" have also proved themselves to be of great importance. Of two machines which are, in general, capable of doing the same amount of work, and are sold for the same price, the one possessing the largest number of talking points will prove to be the best seller. These points are, in the first place, of course, features of real merit in the machine, but in the second place, also features which are of no great importance as far as the working of the machine is concerned, but which nevertheless will attract the attention of the prospective buyer. One feature will draw the attention of one person, another, that of another person, the difference depending largely upon the technical standpoint of the man in question, and, therefore, one feature may be presented to good advantage at one time and in one country, while the same feature may be of less importance in another country and to other customers, depending on the conditions.

The general appearance of the machine, the smoothness of the unfinished cast surfaces, etc., is a point which some buyers pay attention to, while others do not. In Italy, the smoothly finished machine is preferred to the one of a coarser appearance. The writer had an opportunity to compare two lathes, capable of doing the same work, and which sold for about the same price, but one of these lathes was said to sell much better than the other. The special talking points for this better seller were simply that there was, in the first place, a less number of gears in the speed change mechanism running at the same time, and therefore there was less wear and less frictional loss; and in the second place that the pinion for engaging the rack for transmitting motion to the carriage could easily be disengaged, thus permitting the carriage to be pushed back and forth by hand, a feature which really is of small importance. In the stock-rooms of the same dealer a drill press could be seen which was said to sell well. The special feature about this was that instead of the spindle sleeve only being fed down, the whole spindle head with the bearing was fed down with the spindle, on account of which the spindle was less apt to get out of alignment on account of looseness and wear in the bearings. Another point which is found more frequently in German machines than in those of American make, is that nuts which often need to be loosened and tightened for the sake of adjustment are made with handles instead of being hexagon for adjustment by a wrench.

The Italian Automobile Industry.

Up to a few months ago the automobile industry, as already mentioned, occupied one of the leading places in the Italian machine industry. The Italian automobiles have succeeded in establishing for themselves a very high reputation, mostly because of having won prizes in a great many important international automobile contests. A great deal of the success of the Italian motor cars has been due to the importance with which the designing department in Italian motor car factories has always been regarded, and the older Italian automobile concerns have developed designs of very high standing. Nearly all the automobiles made here are of a high class and high priced, and the efforts of the designing department, as well as of the construction department, have been more

in the direction of obtaining the best possible motor car, than in the direction of turning out a car at a price within the reach of the average buyer. Although both the magneto high tension, and the low tension ignition systems are used in the motors, the first mentioned seems to be the one used to the largest extent. This system is more adapted to the high speeds used in automobile contests, while the low tension ignition system is better for ordinary speeds.

Italy as compared with America has an advantage because of its cheap labor. America has supplied Italy with its latest and most up-to-date machine tools, and Italy has been keen enough to learn and adopt a part of the American system of manufacturing, and is now, because of the cheap labor, able to put more efforts into getting the very best possible workmanship. An Italian firm can afford for the sake of good appearance, a thing which attracts the buyer with the long purse, to put exceedingly high finish on parts where it is really not needed; but this increases the reputation of the cars.

In automobiles where lightness is of great consequence, the quality of material used must be the very highest. The gears used in motor cars are, of course, one of the most important of the details, and some of the best concerns stated that they were using a special French steel for the gears, this steel having been developed especially for automobile gearing. The cylinder casting is a part on which much skill and thought has been expended by the designer as well as by the foundryman. The cylinders, because of being subjected to very high temperatures, simultaneously with high pressures, will develop severe internal stresses, which have to be taken care of both by the design and by the manner in which the cylinders are cast. A few of the Italian motor car makers, among them Isotta Fraschini, Milan, do not make their own cylinder castings, but buy them from France and Germany. Other concerns, as R. Züst, Milan, and Fabbrica Automobili Itala, Turin, make their own castings. Although the cast iron used in these cylinders is prepared with special care for the purpose, it seems that the largest importance is placed on the making of the molds.

Foundry Practice in Italian Automobile Factories.

At the outset, the Fabbrica Automobili Itala used wooden patterns for the molding of the cylinders, but in the long run, these became worn, and, therefore, produced castings of untrue dimensions, and besides, other troubles were found to present themselves when using wooden patterns. They, therefore, now use patterns of aluminum not only for the cylinders, but at present make all their patterns from this material. The best material to be used for the molds and cores themselves, has required careful study. For the sake of binding and hardening purposes the molding sand is mixed with potash, sugar, and salt, which mixture is carefully worked in a rotary mixer of the ordinary type, having crushing rolls and mixing blades. This material is used for molds of all kinds, as well as for cores.

Vent holes in the small cores are made in a manner similar to that mentioned in one of my former letters as being used in a German foundry. A thread coated with tallow is put in the core, and when the core is heated for drying purposes, the tallow melts, and the thread can easily be pulled out. A new system of molding is being adopted here and has, in fact, already reached a high degree of perfection. The idea is to divide up the mold into a few integral parts, which can be made entirely separate from each other in the same way as the cores are already made separately from the mold proper. These parts are then assembled to make up a complete mold. This simplifies greatly the art of molding, and also saves a large amount of time and labor, because each integral part, being made separately from the other parts, can be produced in a large number at a time, and stored away until needed for the purpose of assembling the complete mold, which can be done at any time, immediately before the metal is ready to be poured. The writer had an opportunity of seeing a mold for a cylinder piston, made according to this system, assembled and again taken apart. This mold was made in three parts, the first part constituting the bottom of the mold and the core, and the second part being the outer walls, which are made heavy in order to stand the strain produced by the hot metal when poured, and the third part was the top piece, having the necessary holes for pouring and for the vent. The three parts were made to fit nicely into each other, being easy to assemble and still permitting strong joints, a thing which is of great importance. This system is as yet used only for pieces of comparatively simple design, but it is expected that within a short time the same system will be used even for more complicated molds, as, for instance, for the cylinders. These are as yet made in the usual way.

Italian Shop Practice.

During the visits to several of the large automobile shops in Italy the writer had an opportunity to see some of their working methods. It was found that these were very similar in the different shops. A few remarks as to the practices in vogue will give an idea of the present standard of Italian shop practice. The first operation in finishing the cylinders was, of course, to finish the two end surfaces. This was done in a planer. Six to eight cylinder castings are clamped in a line on the planer table, and these are finished by taking one roughing and one finishing cut. When the two end surfaces are finished, the cylinder is set up in a vertical boring mill, where the cylinder proper is bored out to about 0.01 inch below the correct size. This operation is performed by using a special boring tool consisting of a main body, fastened in the toolholder, in which are inserted three single cutting tools arranged at angles 120 degrees apart. The cutting points of these tools are not at the same distance from the center, but arranged so that the first tool takes the first roughing cut in the cylinder, the second tool the second roughing cut, while the third tool takes the final finishing cut. The use of a three-pointed tool with 120-degree angle between the points produced a good balance of the cutting resistance, and the roughing cut, being divided up into two cuts, does not need to be very heavy.

From the boring mill the cylinder was taken to the grinding machine, where the bore was ground to the true size. The internal grinding machine used for this purpose was built so that the cylinder could be placed stationary on the machine, the center of the grinding spindle having a circular or planetary motion around the axis of the cylinder, so as to bring the wheel in contact with each point of the cylinder bore. The next operation is to finish the valve seats. This is done in a vertical boring mill by a double cutting tool, which is made according to the angle of the seats. The tool is marked so as to indicate the depth to which it should be fed down in order to get the seats accurate. Afterwards the sides of the flanges are milled in a horizontal milling machine, the necessary holes drilled, and the other small operations carried out in turn.

The turning of the crank-shafts always involves some difficulties. In the Fabbrica Automobili Itala the crank-shafts were turned in the following way. The first operation was to center the shafts for turning the journals. These were then turned, and the outer plain surfaces of the cranks and the outer ends of the cranks faced. In order to get the centers for turning the four crank-pins, a round fixture was put on at each end of the shaft, these fixtures having the centers drilled into them. With these fixtures on, the shaft was placed between the centers in a lathe, and one of the fixtures was clamped by means of an independent chuck. With the shaft thus fixed, one crank-pin after the other was turned, and the inner sides of the cranks faced. The remaining flat surfaces, which could not be finished in the lathe, were later finished by milling. The journals and the crank-pins were turned somewhat oversize, leaving enough for grinding the crank-shafts, which were held in the grinding machine in the same manner as described for the turning operation.

These indications of Italian shop practice show that work is done very much in the same way as in American shops.

Prospects of the Italian Automobile Manufacture.

It is interesting to note the opinions of a large number of leading machine tool dealers and other persons of technical standing in Italy, regarding the future of the Italian automobile industry. Most of these people do not seem to believe

that Italian automobiles are actually superior to American cars, but answered questions regarding this subject with a smile, saying that Italian automobiles had had "good luck" in contests, but expected that within a few years American motor cars would be imported to Italy.

Wages in Italy.

The wages paid to the average skilled workman in Italy—the machinists, molders, pattern-makers, etc.—vary from 4 to 6 lire ($0.80 to $1.20) per day, and men of more than average skill, such as tool-makers, are paid from 6 to 8 lire ($1.20 to $1.60) a day, all based on a ten-hour day. These figures are as stated by the automobile factories. These used to be the best paying shops in Italy, but on account of the crisis, the wages in the automobile shops were reduced a short time ago, so that the figures given can be considered to be reasonably accurate for all Italian machine shops. Compared with American wages, these are very low, but living expenses are also lower here, and another point to be considered is that the working man is here insured for sickness, and an old age pension is provided, the premiums for which are paid partly by the employer. The regular straight piece-work system seems to be favored in all the shops visited here.

World's Fair in Turin, 1911.

It is, as yet, entirely too early to say anything regarding the contemplated World's Fair in Turin in 1911. The leading men of the industries in Italy, who were interviewed on this subject, did not seem to be very optimistic about the enterprise, but rather the opposite. Their view was, that as far as Italy is concerned, not much could be gained by an exposition, but a great deal of money would be required for the arrangements, and Italy can hardly afford to spend the money for purposes of this kind at the present time. Aside from this, the exhibiting machine manufacturers have to go to a large expense, and are doubtful about whether they afterwards will be amply repaid for this in increased trade.

Trade Conditions in Switzerland.

The industrial conditions which have been noted as existing in the eastern part of Germany and in Italy can also be observed in Switzerland. The manufacturers of machine tools, as well as of other kinds of machinery, have apparently a fair amount of work on hand and are working with full or nearly full force, while the dealers in machine tools complain that business is very dull, and that no improvement in the conditions worth mentioning has taken place. The watch industry in the eastern part of Switzerland, which is of great importance, is at present very dull, largely owing to the fact that on account of the financial depression in the United States no export of watches takes place to this country. In fact, dealers in machinery in Switzerland seem to be more pessimistic about the future than are those in Germany and Italy.

After having visited Germany, Austria, and Italy, the differences in conditions in Switzerland are striking. It appears that the republican form of government has here had an influence on the general spirit even in the machine shops. The pay is somewhat, although not much higher here than in the neighboring southern Germany. Skilled machinists receive on an average 7 francs ($1.37) a day; but more than in the matter of pay does it here appear that the democratic form of government has influenced the ideals of the shop in regard to the relation between the foreman and the men under him. When talking to his foreman, the employe neither is required to, nor does he, assume that attitude of subordination created by the military spirit of discipline which is so commonly observed in Germany. More of the democratic equality is in evidence, and the same spirit is exhibited as is found in most American shops. The visitor realizes this as soon as he is inside the shop, and it becomes still more apparent to him as he is walking around, inspecting the machinery, and watching the men at their work.

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According to a note in *Mercator*, a brick-yard is at the present time being established at Skutskär in Sweden for making "brick" from the refuse from sulphite mills. It is stated that the "brick" thus manufactured possesses all the qualities of ordinary brick.

MISCELLANEOUS FOREIGN NOTES.

German Imports and Exports of Machine Tools.—According to statistical tables published in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, issue of March 25, 1908, the exports of German machine tools in 1907 amounted to 58,051 metric tons, as compared with 22,743 metric tons five years ago. The increase over the previous year amounted to 12,743 tons. The imports in 1907 amounted to 8,175 tons, being a decrease of 5,974 tons, as compared with 1906. Of the imports, nearly 70 per cent came from the United States, and about 11 per cent from Great Britain. The decrease in the imports from the United States, as compared with the previous year, amounted to about 4 per cent. As regards exports, Italy is the largest customer of Germany in the machine tool line. Austria-Hungary, France, Switzerland, and Belgium come next, in the order mentioned. The exports to Italy alone amounted to 12,580 tons, or more than one-fifth of the total exports.

Growth of Russian Industries.—Russia, which until lately imported nearly all her supplies of machinery and other iron products, has of late become an exporting country, the industries of Russia having, during the last years, developed on a large scale. The iron industry has begun to play an important part in the country's exports. Rails and railroad cars, particularly freight cars, have been exported; rails to Servia, Roumania and Argentina, particularly, and railroad cars to Italy. Russia has immense possibilities for industrial extension, having unlimited resources in nearly all directions. Fresh naphtha and coal deposits are constantly being discovered, and mining and manufacture are steadily becoming better organized, and made rational. The primitive methods of the Russians so often referred to, excepting perhaps in agriculture, will soon be a thing of the past. Immigration from European Russia to Siberia is increasing tremendously, and the vast resources of northern Asia are likely to be greatly developed during the next decade.

The Neville Machine & Tool Co., Ltd., 7 James St., Liverpool, England, has brought out an interesting portable radial drilling machine. The base of the machine is mounted on four small wheels, and is also provided with four resting blocks, secured to screws passing through brackets in the base. When the machine is in use, the screws and resting blocks are so adjusted that the base rests on these, instead of on the wheels, and the weight of the machine provides enough stability for any ordinary drilling operation. When the machine is to be moved, the screws securing the resting blocks are turned, thereby lifting the blocks so that the base will rest on the wheels. The radial arm is so mounted that it can be turned through an angle of 360 degrees. The maximum length of the arm is 3 feet 7 inches, having a vertical adjustment over the base plate of 4 feet 11 inches. The base plate is 6 feet 6 inches by 2 feet, and the traverse adjustment of the tool-carrying head is 2 feet.

Trade Conditions in Belgium.—It is reported from Belgium that the iron, steel, and machinery industries are not as crowded with orders as they have been for some time past, and that prices, which have been for some time rather abnormally high, have a tendency to return to a more normal level. Foreign competition, particularly from Germany and Great Britain, is becoming more keen, since in these countries there has been a somewhat smaller demand placed on the industries by the home market during the last few months. It is also likely that before long American competition in Belgium will also influence local conditions, since American manufacturers are likely to have an opportunity for some time to come to devote themselves to foreign trade. The keen competition at home, however, has caused Belgian exporters to make efforts to form a syndicate for promoting their foreign trade. This syndicate is intended to have representatives and selling agents in all the important centers all over the world. Being only a selling syndicate, the proposed capital of $5,000,000 is rather a large one, and the combination may have some future ahead of it. The organization is well systematized, and intends to do banking business and take care of transportation for its members, as well. In general, it might be said that the outlook for the Belgian machinery industry is satisfactory.

MACHINERY AND SUPPLY CONVENTION.

The joint convention of the Southern Supply and Machinery Dealers' Association, the National Supply and Machinery Dealers' Association, and the American Supply and Machinery Manufacturers' Association, met in Richmond, Va., May 13, 14, and 15. Manufacturers and merchants from all parts of the country, engaged in the manufacture of machinery and supplies, and in its distribution, were represented. The three organizations went on record as opposing any reduction of prices at this time. Action was taken looking toward influencing the United States Government in requiring that all goods purchased by the Government should be marked with the name of the manufacturer. Resolutions were passed opposing legislative action in behalf of so-called "anti-trust" and "anti-injunction" measures, and requesting legislation sanctioning the combination of manufacturers and merchants, where such cooperation proves beneficial to the industries and trades, and is not harmful to the public.

A number of addresses were made, among which may be mentioned one by Mr. F. A. Hall, of the Yale & Towne Mfg. Co., New York, who spoke on the subject of "Resale Prices." In connection with this, it may be mentioned that the associations reaffirmed their endorsement of the minimum resale price system. The dealers' organizations pledged themselves to assist the manufacturers in the rigid enforcement of this system wherever adopted. Other addresses of interest were: "Salesmanship," by Mr. W. E. Gerow, of the Atlantic Supply Co., Jacksonville, Fla., and "Commercial Fraternity," by Mr. C. A. Moore, president Manning, Maxwell & Moore, New York City. Mr. D. K. Swartwout, of the Ohio Blower Co., Cleveland, Ohio, gave a "Plain Talk to Jobbers," and Mr. W. M. Pattison, of the W. M. Pattison Supply Co., Cleveland, Ohio, spoke on the "Advantages of Cooperation in Machinery and Supply Business." Finally, Mr. Robert Wuest, commissioner of the National Metal Trades Association, Cincinnati, Ohio, spoke on the "Benefits Derived from Trade Organization," and Secretary Wm. H. Taft, who was invited to address the joint convention, delivered an address on "The Value of Trade Organization." The committee in charge of the convention had arranged for several entertainments, including a smoker and vaudeville performance, at the Jefferson Auditorium, and a banquet.

Mr. J. C. Miller, of Huntington, W. Va., was elected president of the Southern Supply and Machinery Dealers' Association, and Mr. Alvin M. Smith, of Richmond, Va., secretary and treasurer. Mr. George Puchta, of Cincinnati, Ohio, was elected president of the National Supply and Machinery Dealers' Association, and Mr. A. T. Anderson, of Cleveland, Ohio, secretary and treasurer. Mr. Chas. F. Aaron, of New York City, was elected president of the American Supply and Machinery Manufacturers' Association.

* * *

OPENING OF THE MACHINERY CLUB OF NEW YORK.

The Machinery Club of New York, the movement for the organization of which was commenced over a year ago, opened its quarters on the 21st and 22d floors of the Fulton Terminal Building, corner of Fulton and Church streets, on May 21. The purpose of the club is to bring into closer contact the great number of men who are engaged in the machinery business in New York City, and those otherwise interested in the machine industry. The club is also intended to be the headquarters for out-of-town members, and while it will be primarily a lunching club, it is expected that the convenient location and the excellent and pleasant quarters will make it a general meeting place for the machinery trade in New York, and a home-like stopping place for those residing elsewhere, whose business takes them to New York at intervals.

The main feature of the opening was an address by Mr. George A. Post, president of the Standard Coupler Co., who, in some well-chosen remarks, explained the purpose of the club and the intentions of its organizers. A luncheon was also served. The number of people present at this occasion, and the general appreciation expressed of the efforts of those who have been most active in the organization of the club, seemed to indicate the complete success of the undertaking.

The movement for the organization of the Machinery Club was begun on April 4, 1907, when Mr. F. H. Stillman, president of the Watson-Stillman Co., called a meeting of the trade at the rooms of the Board of Trade and Transportation. At this meeting more than two hundred men engaged in the machinery and metal trades and allied industries were present, and a committee was appointed to form an organization. The efforts of the organizers have been well rewarded, 1,100 members having been enrolled before the opening of the new quarters, and there are now more than 500 resident members.

Fig. 1. Main Dining Room, 50 x 150 feet.

The club occupies the entire 21st and 22d floors of the Fulton Building. The main dining room is located on the 21st floor and its dimensions are 50 x 150 feet. Besides this, there is, on the same floor, a large furnished lobby, a grill room, 38 x 54 feet, and a reception room, 26 x 63 feet. A unique feature of the grill room, and one which undoubtedly will be appreciated by out-of-town members, is a large round table placed in a conspicuous place, which is called the club's "open table." The out-of-town members, and others who have but a limited acquaintance in New York, will there find members who will join in conversation with them, as it is an established rule that diners at this table may engage each other in conversation without the formality of an introduction.

Fig. 2. Reception and Reading Room.

On the 22d floor are located an unusually attractive smoking room, an equally attractive ladies' dining room, and several private dining rooms. The 22d floor is the top floor of the building, and a spacious roof-garden will be one of the prominent features of the club arrangements. Much credit is due to the house committee, to which has fallen the task of furnishing the club rooms, and supervising and arranging for the purchase of furniture, etc. The foremost idea of this committee seems to have been to furnish the place in a manner so that it would be comfortable, at the same time avoiding unnecessary luxury or mere useless ornamentation. The

club rooms have the general appearance of being in harmony with the business for which they will become a common gathering place.

A feature that makes the location unusually attractive, aside from its very central position in the machinery district, is the unequaled transportation facilities for reaching the uptown hotel district of New York and the outlying manufacturing districts of Newark, Jersey City, and Brooklyn. The Hudson & Manhattan R. R. connecting with the Subway and joining New York with New Jersey by a great tunnel system, will have its principal station in the sub-basement of the

Fig. 3. Smoking Room.

twin Fulton and Cortlandt Terminal structures. The Cortlandt Terminal Building is also the home of a large club, the rooms of the Railroad Club being on the 21st and 22d floors.

The officers of the Machinery Club are F. H. Stillman, president; R. C. McKinney, vice-president; Walter L. Pierce, treasurer; W. Seton Henry, acting secretary.

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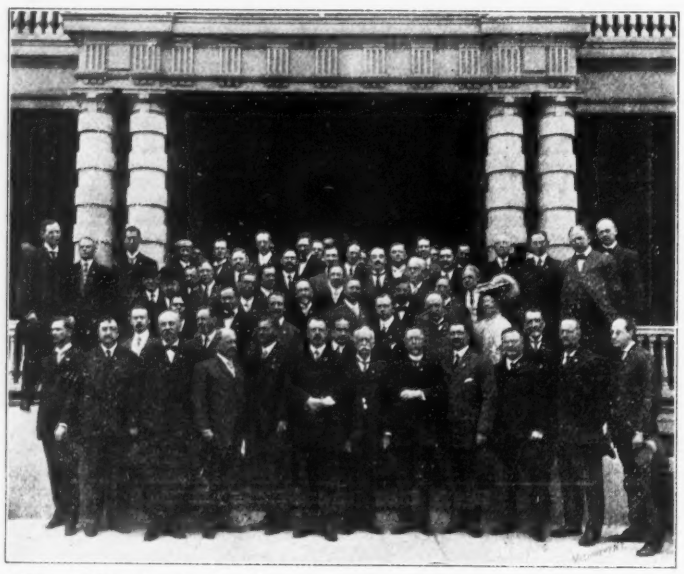
SPRING MEETING OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

The spring meeting of the National Machine Tool Builders' Association was held at the Hotel Chalfonte, Atlantic City, N. J., May 19-20, and was conducted by President Fred L. Eberhardt of Gould & Eberhardt, and Secretary P. E.



Group of Machine Tool Builders and Guests at Atlantic City, May 19, 1908.

Montanus of the Springfield Machine Tool Co. Forty-nine of the ninety-one concerns having membership in the association were registered. Five new members were enrolled, these being the T. C. Dill Machine Co., Philadelphia, Pa.; Edwin Harrington Son & Co., Inc., Philadelphia, Pa.; Ingersoll Milling Machine Co., Rockford, Ill.; International Machine Tool Co., Indianapolis, Ind.; and the Sibley Machine Tool Co., South Bend, Ind.

The more important matters discussed, of general interest, were uniform cost accounting, machine tool prices, cancelation of orders, uniform sale contracts, apprenticeship and readjustment of railway rates. The report of the committee on uniform cost accounting, presented by Mr. C. Wood Walter of the Cincinnati Milling Machine Co. in the absence of Mr. F. A. Geier, the chairman, was accompanied by a pamphlet prepared for the association by the Miller & Franklin Co., Boston, Mass., which explains the system in detail.

It was unanimously agreed that there was no good reason for changing the present prices of machine tools. The cost of materials has undergone little or no reduction, pig iron being almost the only exception, and wages are practically unchanged. With the resumption of business, machine tools will actually cost more than before the panic because of the inefficiency of new help that must be taken on and trained to replace the men laid off. The association placed itself on record in favor of arbitration among its members, it being recommended that the parties in dispute each choose a representative and these choose a third to act as a board of three to settle the matter. It was the sense of the association that differences in patent matters could be adjusted in this way very much more satisfactorily and cheaply than by recourse to the courts.

The cancelation of orders by buyers of machine tools is a particularly sore subject just now, and much warmth of feeling was displayed in this discussion. The injustice of the present custom which permits an intending purchaser to cancel any or all orders for machine tools at will was pointed out, and resolutions were adopted to discourage the practice. Other lines of manufacture do not countenance cancelation of orders, the purchaser being unable to break contracts without the consent of the manufacturer or without forfeiting a certain part of the purchase money deposited when the contract was made. In the report by Mr. C. A. Johnson of the Gisholt Machine Co., a uniform contract was recommended that should cover cancelation and provide that title to all machinery sold should not pass to the purchaser until the full purchase money had been paid. The defective business practice of jobbing foundries which supply machine tool castings was caustically referred to by Mr. C. H. Norton of the Norton Grinding Co. in a minority report, and American practice was compared with European practice, much to the advantage of the latter.

Mr. J. H. Cone, of the National Metal Trades Association, of Cincinnati, addressed the meeting just before adjournment on cooperative engineering education, and noted the remarkably good results that have come from the innovation in the Cincinnati University. Not only have the students who took the coöperative engineering course been able to keep abreast of their classes, although in school but half time, but their examinations were higher in average rating than those taking the full time course. More remarkable has been the effect on the system of teaching. The practical knowledge obtained by the boys alternately working one week in the Cincinnati shops and one week in the university shows the weaknesses of much mechanical engineering instruction. It is believed that this system of mechanical education will spread, as its practical benefits become known.

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PERSONAL.

John E. Willard has been made manager of the Union Gas Engine Co., San Francisco, Cal.

Norman G. Meade, electrical expert and occasional contributor to MACHINERY, is now with the New York Edison Co. in charge of the editorial work on the *Edison Bulletin*.

G. O. Gridley, manager of the Windsor Machine Co., Windsor, Vermont, will sail for England the first week in June. Mr. Gridley expects to be gone about six weeks.

Herbert C. Petty has been elected a director of the Crocker-Wheeler Co. Mr. Petty entered the service of the company in 1903, and advanced rapidly to the position of contract manager.

Edward B. Busby, formerly with the Midvale Steel Co., is now employed in the selling department of the Electric Welding Products Co., Cleveland, Ohio, formerly the Cleveland Cap Screw Co.

J. E. Merrill, foreman pattern-maker of the Waterbury Mfg. Co., Waterbury, Conn., has left that concern to take charge of the pattern shop of the Bridgeport Foundry and Machine Co., Bridgeport, Conn.

Russell A. Stinson, vice-president of the Canadian Crocker-Wheeler Co., Ltd, Montreal, recently organized, has been identified with the manufacture, construction and sales end of the electrical trade in Canada for the past fifteen years.

T. W. Meachem, president of the New Process Raw Hide Co., has been elected president of the Chamber of Commerce of Syracuse, N. Y., which is a merited recognition of business ability from a community where Mr. Meachem is well known.

F. E. Lovell, president of the Canadian Crocker-Wheeler Co., Ltd., Montreal, is a member of the old-established lumbering firm of H. Lovell & Sons, Coaticocke, Quebec, which has extensive interests in mills and timber lands throughout the province of Quebec.

F. John Bell, secretary-treasurer of the Canadian Crocker-Wheeler Co., Ltd., has been identified with the electrical trade in Canada for the past fifteen years, and is well-known in Montreal, where the head office of the company has recently been opened.

Dr. Schuyler Skaats Wheeler, past president of the American Institute of Electrical Engineers, and president of the Society of Engineers, addressed the engineering society of Columbia University, May 4, on the subject of engineering honor. Dr. Wheeler mentioned the three great duties of the engineer in the order of their importance: First, the engineer's attitude to his client; second, to the public; and third, to his engineering society. He strongly condemned the publication of all fake scientific and engineering statements, and insisted that discoveries and inventions should be announced not in the daily papers, but through technical societies or through the technical press.

The many friends and admirers of Prof. William Kent, dean of the College of Applied Science, Syracuse, N. Y., and compiler of Kent's "Mechanical Engineer's Pocket Book," are much interested in the controversy raging between him and Chancellor James R. Day, of the university, over the former's action in regard to the alleged perilous condition of certain of the university buildings. Following the terrible school building fire in Collinwood, Ohio, March 4, in which 165 children died, Dean Kent called attention to the lack of fire escapes and fire protective construction in the College of Applied Science building, claiming that the conditions were extremely hazardous, but was ridiculed for his pains. He applied to the public authorities of Syracuse for an investigation, the result being that his claims were sustained. As a result of going over the chancellor's head, Dean Kent's resignation has been demanded. This he has refused to give because his actions were dictated by motives of public policy, being what any citizen had a right to do. No reflection has been cast on his ability as an educator or engineer, the demand for resignation being made because of disregarding the opinion of the chancellor on a matter of safeguarding human lives.

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OBITUARY.

Arthur Koppel, head of the Arthur Koppel Co., New York, died suddenly of heart disease at Baden-Baden, Germany, May 13. Mr. Koppel was fifty-six years old. He leaves a wife, three sons, and a daughter.

We announce with deep regret the sudden death of our Paris representative, Mr. Eloi Delmouly, who was asphyxiated by the gas from a stove set up for heating purposes. Mr. Delmouly was well known as an engineer in his special field. He was a bachelor with no relatives in Paris, and will be buried at his native place, Agen, in the southern part of France.

Francis B. Stevens died at his home at Castle Point, Hoboken, N. J., May 23, at the age of nearly ninety-four years. Mr. Stevens was born at Trenton, N. J., October 16, 1814. He was

William Dana Ewart.

educated in the New York University and became a civil engineer. He made a number of inventions, the best known of which is the Stevens cut-off, first applied to the steamboat *Albany* in 1840. His uncle, Edwin A. Stevens, was the founder of Stevens Institute.

WILLIAM DANA EWART.

The death at Rome, Italy, on Sunday, May 3, of William Dana Ewart, will be noted with more than ordinary regret by those whom his genial disposition had made his friends and by the many others to whom his most prominent invention has made his name familiar. Mr. Ewart was born in Ohio about fifty-six years ago, and at a comparatively early age gave evidence of an inventive mind and rare mechanical ability. He was the inventor of the malleable-iron detachable drive chain, first known under his name and in later years as link-belt, which has formed an important part of agricultural and other interchangeable machinery, and has, to possibly a greater extent than any other single invention, helped the wonderful progress in the development of elevating and conveying machinery during the past thirty years. This drive chain has been continuously manufactured by the Ewart Manufacturing Company and exploited by the Link-Belt Machinery and Link-Belt Engineering Companies till, in 1906, all three companies were consolidated into the Link-Belt Company, a corporation in which he was largely interested, and whose fortunes are still largely directed by his former associates. Mr. Ewart, whose abilities brought their proper reward, was not only an inventor, but a man of executive capacity, possessing a rare gift for harmonizing differences and securing cooperation. His health becoming impaired, he retired in his early prime from the activities of business and sought renewal of physical strength under more favorable climatic conditions abroad.

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From time to time we have mentioned in these columns some experiments that have been carried on in Europe to perfect the process for the production of alcohol from peat, initiated nearly forty years ago. It is now stated that important progress has been made in the last two years by a Frenchman, Raynaud, and that the results obtained are so encouraging that a plant for manufacturing alcohol from peat on a commercial scale will be erected in northern Germany. According to statements made by Professor Ramsay, one ton of dry peat will furnish 42½ gallons of pure spirits, giving as a by-product about 66 per cent of sulphate of ammonia. Owing to the fact that the only obstacle to the more extended use of alcohol at the present time is its price, this process, if successful, will tend to solve an important power problem of the future, it being asserted that the manufacturing cost of one gallon of 97 per cent alcohol will be only about ten cents.

A WARNING TO MACHINERY DEALERS AND MANUFACTURERS.

Iron and steel companies, machine manufacturers, hardware dealers, etc., are cautioned against transacting business with a party who is at the present time floating worthless checks. His methods of operating are first to write to a certain concern for a catalogue, etc., from an address in almost any part of the country. Later he calls upon such firm with said catalogue and certain articles marked, asking to see these goods and places an order for same, giving a fictitious address. He then asks if a deposit is desired on the transaction and fills out a blank check in sums ranging from $200 to $1,500. Sometimes he gives a large check in part payment and asks for a certain amount, probably one-third or less, to be given him in cash for necessary expenses as he has no one in the vicinity who can identify him in order to have a check cashed.

He may use almost any name, but is known to have operated under names of: K. S. Miller, H. B. Miller, P. P. Hilliard. He is described as being an American, 28 years of age, 5 feet 7 inches tall, 160 pounds in weight, good build, dark hair, smooth shaven and has a large burn scar on the left side of his face. Any information relative to the operations of this party that will be referred to the American Bankers' Association or their agents, Pinkerton's National Detective Agency will receive prompt attention.

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THE TWO-JAWED LATHE CHUCK PATENTED.

An article was published in the May issue by Mr. Ethan Viall describing a two-jawed lathe chuck used by the H. Mueller Mfg. Co., Decatur, Ill., with the statement that the chuck was patented in 1889 and, therefore, that the patent had expired. We are informed by the patentee, Mr. Edward Marcille, Peoria, Ill., that this statement is an error, the chuck having been patented January 3, 1899, instead of in 1889. Consequently our readers will know that this interesting and valuable chuck construction is not open to the public.

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Beginning with the issue of June 5, the *Railroad Gazette* of New York and the *Railway Age* of Chicago, will be issued as a single combined weekly periodical, under the name of the *Railroad Age Gazette*, with the publication office in New York. Both papers have been long established, the *Railroad Gazette* for more than fifty-two years, and the *Railway Age* for thirty-two years. The changed conditions in railway business have made the advertising support inadequate for two expensively conducted journals in the field.

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NEW BOOKS AND PAMPHLETS.

HANDBOOK OF MATHEMATICS FOR ENGINEERS. By L. A. Waterbury. 91 pages, 2¾ x 5½ inches. Published by John Wiley & Sons, New York. Price $1.00.

This little work is intended to be a vest-pocket handbook of mathematics for engineers. It treats of algebra, trigonometry, analytical geometry, differential calculus, integral calculus, theoretical mechanics, mechanics of materials. A thumb index is provided for convenient reference and a special index makes the work very convenient for reference.

STRENGTH OF CHAIN LINKS. By G. A. Goodenough and L. E. Moore. 73 pages, 6 x 9 inches, illustrated. Published by the University of Illinois, Urbana, Ill.

This bulletin, No. 18, records results of a series of tests to determine the strength of chain links, and to verify the laws and formulas for the strength of chains. The appendix gives at length the theory of stresses in curved bars, analysis of the open link, derivation of theoretical formulas for the change of length in the axis of the link, and analysis of stud link. The pamphlet is one of much practical value to designers and engineers having use for chains in machinery or for handling materials.

AUTOGENOUS WELDING OF METALS. By L. L. Bernier. 45 pages, 4½ x 6½ inches. Published by the *Boilermaker*, 17 Battery Place, New York City. Price $1.00.

This pamphlet is a description of the application of autogenous welding to the manufacture of tanks and other receptacles made of plate metal. The autogenous process is essentially a welding process, the heat of the oxy-acetylene flame being so great that the metal at the joint is fused and joined together into a perfect weld. The flame may be made oxidizing or non-oxidizing to suit the requirements of the case. In welding it is of course made non-oxidizing and when used for cutting metals apart it is preferably oxidizing. The importance of the process for tank making is obvious.

THERMODYNAMICS OF TECHNICAL GAS REACTIONS. By F. Haber. 356 pages, 6 x 9 inches. Published by Longmans, Green & Co., New York. Price $3.00, net.

This book is made up of seven lectures on chemical reaction and its relation to reaction energy; entropy and its consequence in gas reactions; derivation of formula, and its effect on reactions of solids; examples of reactions which proceed without change in the number of molecules; examples of reactions involving a change in the number of molecules; the determination of the specific heats of gases; and the determination of gas equilibria, with the theoretical and technical discussion of related questions. The work is technical and of interest to those only concerned with the chemical and technical problems of thermodynamics.

TABLES AND OTHER DATA FOR ENGINEERS AND BUSINESS MEN. Compiled by Chas. E. Ferris, Professor of Mechanical Engineering, University of Tennessee. 160 pages, 2½ x 5½ inches. Published by the University Press, Knoxville, Tenn. Price 50 cents.

This little vest-pocket manual for engineers was issued primarily to advertise the University of Tennessee. The large demand for it shows that it meets a common want, the present issue being of the tenth edition. It contains metric conversion table, tables of areas and circumferences of circles, tables of squares, cubes and reciprocals, weights of rivets and round head bolts; weights and areas of square and round bars; weights of sheet or wrought iron, steel, copper and brass; tables of sines, tangents and secants, hyperbolic logarithms, and many other tables of common use among engineers.

THE STEAM TURBINE. By Robert M. Neilson. 604 pages, 6 x 9 inches, 387 illustrations. Published by Longmans, Green & Co., New York. Price $4.20, net.

The first edition of Mr. Neilson's work was issued in 1902. This book is of the second edition, in which the descriptions of Parsons and De Laval steam turbines have been considerably enlarged, as well as the chapter on marine propulsion. A new chapter has been added, in which the Parsons, Stumpf, Schulz, Curtis and Seger turbines are described. The book treats of the fundamental notes and definitions of the steam turbine, the conversion of heat energy and steam into kinetic energy, types of steam turbines, losses and efficiency, steam turbines of five classes, low pressure steam turbines, effects of steam pressure, superheat and vacuum on efficiency, etc. An appendix contains a list of British patents on steam turbines from the earliest records up to the end of 1905. The work will be found a very satisfactory treatise on the subject and can be recommended to those interested in mechanical construction and theoretical treatment.

BETTERMENT BRIEFS. By H. W. Jacobs. 240 pages, 6 x 9 inches, 132 illustrations. Published by the author, Topeka, Kansas.

The work is a collection of some contributions on railroad betterment that have been published from time to time, and are now brought together and bound in book form. The author is assistant superintendent of motive power of the Atchison, Topeka & Santa Fe Railway System, Topeka, Kansas, and has had an unusual opportunity of studying the organization and efficiency of the railway machine shop. It illustrates many time-saving devices that are in daily use and gives particular attention to the use of high-speed steel on the lathe, planer, milling machine and other machine tools. An example of motion pictures is given on page 158, which were taken for the instruction and the entertainment of the men. These pictures show examples of machine work, firing locomotives, etc., and help to enlist their interest and co-operation in the promotion of more efficient methods. The work as a whole is one that can be most highly recommended to railway shop master mechanics, superintendents of motive power and all concerned in the increase of the efficiency of railway repair shops.

MACHINE DESIGN, CONSTRUCTION AND DRAWING. By Henry J. Spooner. 691 pages, 6 x 9 inches. About 1,500 figure numbers and 4 folding plates. Published by Longmans, Green & Co., New York. Price $3.50.

Sixty-five pages of the work are devoted to the subject of drawing, being on drawing instruments, materials, scales, and drawing to scale; how to draw straight lines and simple figures; circular arcs and lines, and how to commence a working drawing. Then follow chapters on machine details, including leather collars, shafting, crankshafts, cranks, journals, couplings, clutches, key and keyway, riveted joints, bolts, nuts, screws, pipe and pipe connection, cotters and cottered joints, bearings, journals, hangers, roller and ball bearings, toothed gearing, friction gearing, wire rope gearing, chains, crane hooks, steel and iron cranks, pistons and piston rods, cross-heads, guides, connecting-rods, engine eccentrics, machine handles, materials used in construction of machines, strength of beams, hints on designing machines and machine parts, springs, miscellaneous. The work is voluminous, and certainly covers a large amount of engineering matter. It should be of general value to students, draftsmen, engineers and others concerned in machine construction and detail.

BRENNAN'S HAND BOOK. A compendium of useful legal information for business men. By B. A. Brennan, contract manager of the Westinghouse Machine Co. 571 pages, 4 x 6¼ inches. Published by *The Electric Journal*, 422 Sixth Ave., Pittsburg, Pa. Price $6.00.

This book was compiled to meet the wants of the author, who is the contract manager of the Westinghouse Machine Co., and contains a synopsis of the statutes bearing on the collection laws of the different states and useful legal forms. The work by sections is: I. Contracts in general; II. Sale Contracts; III. Property, Deeds, Mortgages, Liens, Interest; IV. Acknowledgments, Power of Attorney, Licenses, Guarantees, etc.; V. Notes, Checks, Interest; VI. Negotiable Instruments; VII. Synopsis of Statutes on Conditional Sales, Chattel Mortgages, Bills, Notes, Forms of Acknowledgments; VIII. Collection Laws Tabulated; IX. Legal Forms. It is obvious that this publication of legal lore, presented in everyday language, is of the greatest value to manufacturers, shop managers, merchants, dealers, and others doing business in various states. The book is well printed and bound in flexible leather, with gilt-edged pages, being suitable for the library, desk or traveling purposes.

POWER AND POWER TRANSMISSION. By E. W. Kerr. 366 pages, 6 x 9 inches. 263 illustrations. Published by John Wiley & Sons, New York. Price $2.00.

This book is made up largely of the subject matter of lectures delivered by the author, who is professor of mechanical engineering, Louisiana State University. The present issue is of the second edition, in which the chapters on steam turbines and valve diagrams have been rearranged and added to. A valuable feature is practical problems; 175 problems and 10 pages more of matter have been added. The work defines the terms used in machinery and mechanics, and treats of shafting, bearings, frictional lubrication of bearings, friction wheels, pulleys, bevel gearing, screws, cams, the lathe, pipe fittings, heat, steam, simple steam engines, automatic cut-off engines, indicators, compound engines, valves, valve gearing, valve diagrams, rotary engines, steam turbines, pumping machinery, gas engines, compressed air and hot air engines. The book has one fault common to many otherwise excellent American technical books, and that is the liberal use of manufacturers' electrotypes of a style and size totally unsuitable to the general character of the work. The book is well suited to the needs of students in mechanical and engineering courses.

ELEVATOR SERVICE. By Reginald Pelham Bolton. 69 pages, 7½ x 10¾ inches. Published by the author, 527 Fifth Ave., New York. Price $5.00.

This work treats of the conditions and proportions of elevators, and gives diagrams, formulas and tables for passenger travel, relation of the elevators to the building, and proportions and loads of cars. Its contents by chapters are: I. Problem of Vertical Transportation; II. Conditions; III. Passengers and Operators; IV. Rating the Work of the Elevator; V. Computing the Average Work; VI. Shape and Size of the Car; VII. Load and Speed Conditions; VIII. Building Its Prearranged Surface; IX. Examples of the Use of Large Chart Giving the Relation of Elevators to Area of Floors; X. Definitions of Some Terms Used in Connection with the Elevators. The problem of vertical transportation has become one of the most serious that the constructing engineer has to deal with in the modern office

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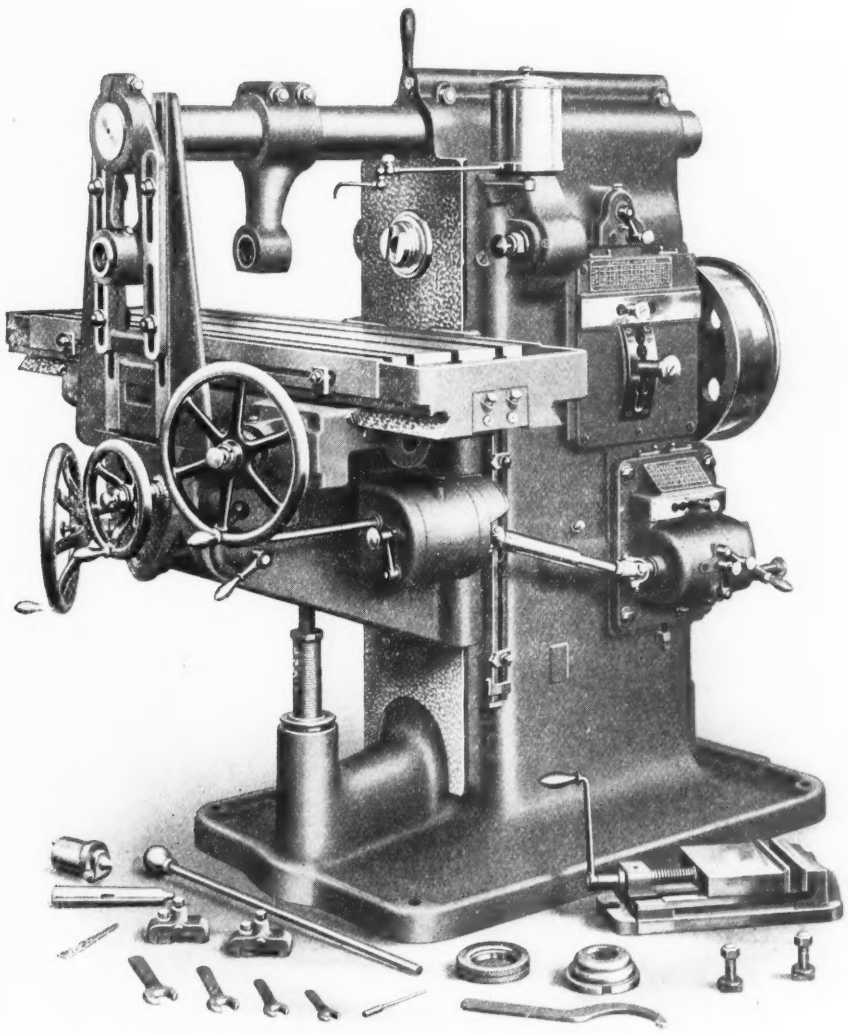


With the Constant Speed Drive Milling Machine, the Advantage of Ample Power.

The growing use of High Speed Steels requires of milling machines increased power, especially in large machines, and those factors which are necessary to develop power are realized to the fullest extent in this type of machine. The constant speed drive permits the use of countershaft and machine pulleys of large equal diameter, taking a wide belt and running at a high constant speed. This gives large belt contact and high belt velocity, the two requisites of power.

The Constant Speed Drive Booklet, giving other advantages of this type of machine, sent to any address upon application.

building. As the height of buildings increases the difficulty of obtaining the necessary elevator capacity without absorbing so large a proportion of the available floor space as to render the building unprofitable, becomes greater and greater. The work before us is an analysis of present conditions, and contains many valuable suggestions and ideas on the problem in general.

ACCIDENTS; THEIR CAUSES AND REMEDIES. By Thos. D. West. 95 pages, 5¼ x 7¾ inches. Published by the Competent Life Book Agency, Sharpsville, Pa. Price 25 cents.

This work is a treatise on the development of care and faithfulness to aid the safeguarding of life and property. It was written by a man of large practical experience and a well-known writer on technical subjects. Mr. West opens the first chapter with a statement that our Spanish wars, during the past ten years, killed and wounded about 6,000 men, whereas our peace institutions of recreation and work maimed and killed, within the same time, over 5,000,000. This statement alone should be sufficient to challenge the attention of every thinking man and woman. The pamphlet is illustrated with views of the Collinwood disaster, in which 165 persons died, and which is a horrible example of wrong building construction and careless oversight. The pamphlet treats of the needs of carefulness in recreation; the number of maimed and killed by accidents; waste through weak and vicious inhabitants; fire losses through smoking; reducing accident, fire and life insurance; The American Museum of Safety Devices and Industrial Hygiene; factors affecting safety devices; colleges' handicap in developing prudent overseers; value of civic pride and efforts in preventing accidents, etc. The pamphlet is one that should interest manufacturers and it is one, we think, that they could profitably assist in circulating among their own help.

CATALOGUES AND CIRCULARS.

THE JEFFREY MFG. CO., Columbus, O. Catalogue No. 76, illustrating and describing line of rock drills.

BOSTON GEAR WORKS, Norfolk Downs, Mass., Circular D1 of standard steel mitre bevel gears with generated teeth.

THE BRUCE-MERIAM-ABBOTT CO., Cleveland, O. Catalogue of vertical gas engines for electric lighting, pumping and general power purposes.

BOSTON GEAR WORKS, Norfolk Downs, Mass. Catalogue EI of gears, chains, sprockets, bearings, shearing devices, etc.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4579, descriptive of luminous arc headlights for interurban roads or heavy railway service.

THE WEBER GAS ENGINE CO., Kansas City, Mo. Brochure No. 57, illustrating an electric light plant, operated by the Weber gas engine and suction gas producer. This plant generates power at a consumption of 1 1/5 pound of coal per brake H. P. hour including stand-by losses.

MUNN & CO., 361 Broadway, New York. *Scientific American* Index of Manufacturers, compiled from the recent and current advertisements of the *Scientific American* publications, which include the *Scientific American*, *American Homes and Gardens*, the *Scientific American* (Export Edition) and *La America Scientifica*.

W. N. BEST AMERICAN CALORIFIC CO., 11 Broadway, New York. Catalogue of the "Calorex" liquid fuel equipment for burning oil or tar in marine, locomotive and stationary boilers, terra cotta, lime and cement kilns, and "Calorex" oil burning furnaces and equipment for hardening, tempering and melting metals.

THE GENERAL ELECTRIC CO., Schenectady, New York. Bulletin No. 4584, descriptive of the type CQ motor. This motor is made for direct current circuits up to 20 H.P., and for 115, 230 and 550 volts. It is specially adapted to linotype equipments, machine tools and other apparatus requiring reliable motor.

SKINNER CHUCK CO., 94 N. Stanley St., New Britain, Conn. Illustrated and descriptive catalogue for 1908 on Skinner lathe, drill and planer chucks. This catalogue shows the Skinner 1908 pattern independent lathe chuck and the geared pattern new model drill chuck, both of which were recently put on the market.

DIAMOND MACHINE CO., Providence, R. I. Catalogue of the American grinding attachment and American center grinders for grinding lathe centers, and milling cutters, reamers, etc., on an engine lathe. The attachments are made to be driven from the cone pulley by a friction disk, by electric motors or by hand.

EMERSON ELECTRIC MFG. CO., St. Louis, Mo. Bulletins Nos. 3124, 3125, 3212, 3126, 3803 and 3905, illustrating and describing single phase induction motors of ⅛, 1/6 and ¼ H. P., bipolar motors ¼ to ½ H. P., single phase induction motors, ¼ to ½ H. P., motor-driven air pumps and motors with transmitters for factory sewing machines.

THE UNION SWITCH AND SIGNAL CO., Pittsburg, Pa. Catalogue of alternating current block signal appliances. It is claimed that the alternating current track circuit is most reliable means for avoiding false clear signals due to the effect of foreign currents, and that its use reduced the cost of maintenance. The catalogue is illustrated and the various apparatus is briefly described.

DIAMOND MACHINE CO., Providence, R. I. Catalogue of wet tool grinders, belt and motor-driven. These machines are furnished with or without truing devices and all the larger sizes have hoods and circulating pumps for supplying a stream of water directly above the work being ground. The smaller sizes have hoods and a fountain above the wheel.

THE GENERAL ELECTRIC CO., Schenectady, New York. Bulletin No. 4578, descriptive of railway motor controllers. Details of some of the controllers are given, describing the magnetic blow-out, the cut-out switches that facilitate removing any motor from the circuit, without affecting the operation of the remaining motor or motors, interlocks which, to a great extent prevent misuse of the controller by the motorman.

O. C. WHITE CO., 17 Hermon St., Worcester, Mass. Circulars descriptive of the White adjustable shop and office fixtures for incandescent lamps. These fixtures, illustrated in the April, 1907, issue of MACHINERY, enable the user to put the light in any position required so as to throw the rays directly on his work. They are particularly well suited to shop use, and have been installed in the machine shops of the Worcester Polytechnic Institute, where they are well liked.

THE GENERAL ELECTRIC CO., Schenectady, New York. Sixteenth annual report to the stock-holders. The report indicates that the assets are $98,525,765.14, in which all patents and franchises are listed at one dollar. Liabilities are $16,844,529, in the shape of debentures of 1892, 1902, and 1907, interest on same, accounts payable and unclaimed dividends. The capital stock is $65,167,400 and the surplus is $16,513,836.14.

THE LINCOLN MOTOR WORKS, Cleveland, O. Bulletin No. 10, descriptive of the Lincoln variable speed motor, type 80, which requires no controller, and which has speed variations, ranging from 1 to 10. The bulletin illustrates the application of the motor to lathes, bolt cutters, heavy drilling machines and shapers, and the construction details are also illustrated. Speed and efficiency charts are given, tables of ratings, together with a partial list of users.

THE MCGRAW PUBLISHING CO., 239 W. 39th St., New York. Brochure descriptive of the new home of the McGraw Publishing Co., which is an interesting example of reinforced concrete construction. The building has a frontage of 136 feet and a depth of about 90 feet, its total height above the basement being 159 feet. All footings of the building are carried down to the solid rock and the first and second floors are designed for a live load of 250 pounds per square foot.

CARL MAHR, Esslingen, a. N., Germany. Catalogue of precision measuring instruments, illustrating a great variety of all kinds and classes of measuring instruments, including micrometers for outside and inside measurements; micrometers provided with special sensitive measuring attachments; micrometers for measuring thickness of paper, rubber sheets, etc.; special micrometers for measuring large dimensions; combination squares; speedometers; all kinds of gages; compasses; scales; rules; general machinists' tools; gages for car wheels and railroad shop work in general. Many of the tools shown present original ideas and a development differing from the ordinary type of measuring instruments.

WARNER & SWASEY CO., Cleveland, Ohio. Leaflet announcing that the company has moved its New York offices from the Singer Building Annex to the new Singer Building, where it will be on the twenty-fourth story in the tower. The new offices will enable the company to better serve its machine tool customers in the eastern and northeastern States. The location of the offices in the Singer Building tower affords many interesting views of the city and surrounding points. For observation purposes a Warner & Swasey terrestrial telescope and a prism binocular are provided for the use of customers and friends.

JOHNSTON OIL ENGINE CO., LTD., Toronto, Canada. Booklet descriptive of the Johnston crude oil engine. Arrangements have been made for the manufacture of the Johnston crude oil engine under the Johnston patents in the United States, England and other countries. These engines run on any kind of crude oil fuel without fouling and are claimed to develop power cheaper than steam engines, gas engines on city gas, gasoline or kerosene engines, and even gas engines working on producer gas, except in localities where coal is very cheap and fuel oil is dear. The Johnston engines will be made in large stationary, small stationary, large marine, small marine, traction and portable engine types. The company will also build automobile engines, rail motor-car engines, and locomotives.

MANUFACTURERS NOTES.

THE UNION GAS ENGINE CO., San Francisco, Cal., has opened a large store at 503-5 Mission St., San Francisco, Cal.

ELECTRIC CONTROLLER AND SUPPLY CO., Cleveland, Ohio, has removed its New York office from 120 Liberty St. to the Fulton Building, Hudson Terminal, 50 Church St.

I. P. RICHARDS CO., Providence, R. I., is the firm name succeeding I. P. Richards, maker of U. S. standard punches for iron and steel boiler plate, etc.

ADJUSTABLE COLLET CO., Cleveland, Ohio, reports an unusual increase of orders during the last thirty days, and it will increase its shop equipment at once.

LOEW MFG. CO., Cleveland, Ohio, reports that the present business outlook is very encouraging. The manager, Mr. C. E. Cross, has started five new salesmen on the road to sell the Victor pipe cutting machine, illustrated in the May issue of MACHINERY.

GENERAL PNEUMATIC TOOL CO., Montour Falls, N. Y., has changed its name to Shepard Electric Crane and Hoist Co., in order to better fit the name to the output, which is electric cranes, electric hoists, pneumatic hoists, riveters and trolleys.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Drill point paper weight made of "Franklin" metal to show the proper form to which twist drills should be ground to obtain the most lasting service and best efficiency when working under average conditions.

STERLING EMERY WHEEL MFG. CO., Tiffin, Ohio., announces that its Chicago store has been moved from 30 S. Canal St. to 60 W. Washington St., and that a large stock of Sterling grinding wheels and machinery is now ready for inspection at the new store.

O. C. WHITE, CO., 17 Hermon St., Worcester, Mass., has opened a New York office and stock-room at 19 Park Place and 16 Murray St. for handling its line of standard adjustable electric fixtures for offices, shops, drafting-rooms, factories, etc. The New York branch will be managed by Mr. Frederick Rall, well known in the New York electrical trade.

C. BAERWALDE has severed his connection with Koch & Baerwalde Mfg. Co., Cleveland, Ohio, and has started a specialty manufacturing business under the name of the Cleveland Specialty & Mfg. Co., 3001 Searsdale Ave., S. W., Cleveland, Ohio. At present the specialties made are water motors, water fans, tapping attachments, tapping machines, drill jigs, electric fan and magnet winders.

THE PITTSBURG AUTOMATIC VISE AND TOOL CO., Pittsburg, Pa., has received a second large order from the Japanese Government for vise equipment. This shipment was sent to the Imperial Steel Works, and consisted of double-swivel vises exclusively. It is claimed that, with the exception of three or four small countries, the Pittsburg vise is now in use in almost every government shop in the world.

THE National Society for the Promotion of Industrial Education has decided to organize state associations. At the meeting of the board of managers recently held in New York City plans were perfected for establishing these branch societies in thirty-eight states. This testifies to the rapid growth of the society, which held its first annual meeting in January of this year at Chicago. The society has established permanent headquarters at 546 Fifth Ave., New York City.

THE NORTHERN ENGINEERING WORKS, 26 Chene St., Detroit, Mich., has just designed a five-ton, three-motor electric steel derrick, of 75 feet radius, 60 feet lift, at the plant of the St. Louis Basket and Box Co., St. Louis, Mo. It is of the high speed type, hoisting at a speed of 60 to 124 feet per minute. All its motions are operated by electric motors. The derrick is supported by heavy, stiff legs, the frame and stiff legs being entirely of lattice steel construction.

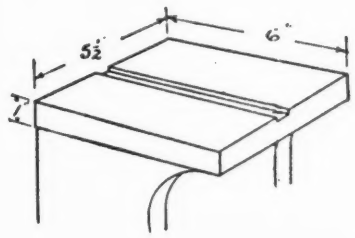
AUTO PAPER FEEDER CO., 198 Broadway, New York, has been organized under the laws of New York State with $50,000 capital to manufacture feeding machines for printing presses, folding machines, rotary copying machines and other machines through which paper has to be fed sheet by sheet. The officers are as follows: President, Charles Hanau; treasurer, Rudolph Hanau; vice-president, Joseph Kleidman; and consulting engineer, Martin Joachimson.

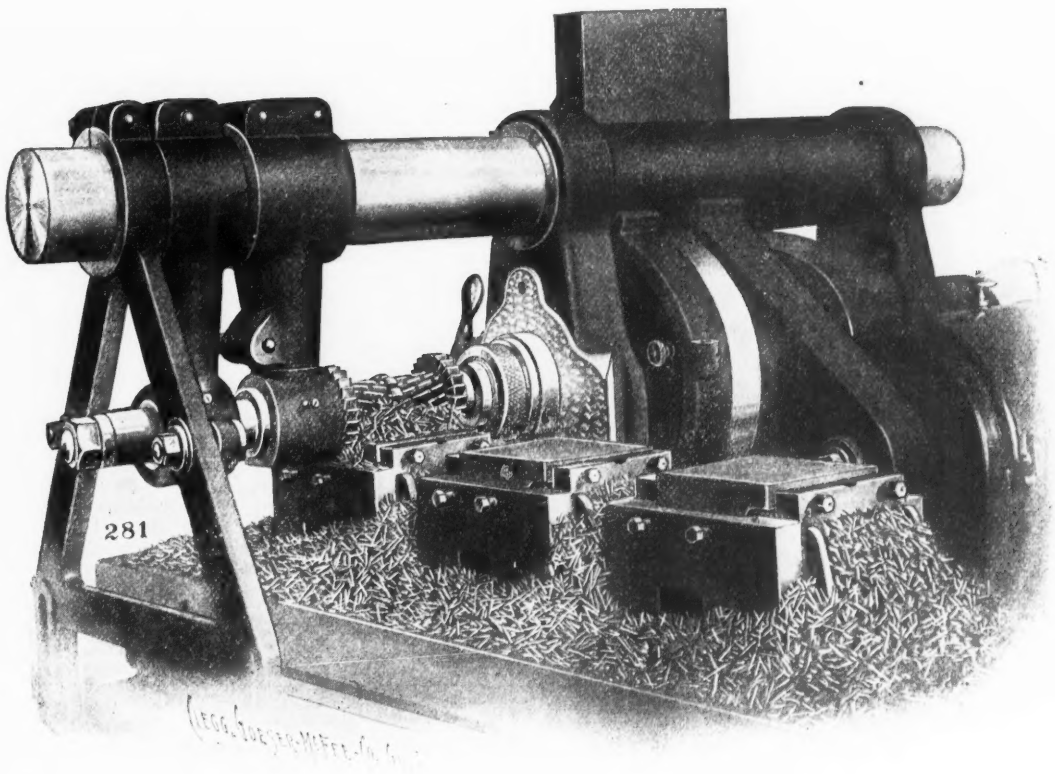
CROCKER-WHEELER CO., Ampere, N. J., has demonstrated its confidence in the business situation by the organization of the Canadian Crocker-Wheeler Co., Ltd., for the manufacture and sale of Crocker-Wheeler apparatus in Canada. The president is F. E. Lovell, and Russell A. Stinson and F. John Bell are vice-president and secretary-treasurer respectively. The office of the Canadian company will be in Montreal, in the Street Railway Chambers, Place d'Armes Hill.

CASSIER'S MAGAZINE CO. has removed its New York offices from No. 3 West 29th St. to No. 12 West 31st St. The new home of the magazine is in the office building just erected on the site of the former home of the American Society of Mechanical Engineers and is in a location especially convenient of access from the new railroad terminals and is easily reached by the various systems of local transport from all parts of the city.

GOLDSCHMIDT THERMIT CO., 90 West St., New York, has established an office and works at 198 Richmond St., W., Toronto, Canada. The new branch was opened for business May 1, and is under the man-

MILLING TIME

HALF A  MINUTE



Our No. 4 Plain Motor Driven Miller

takes a cut across these cast-iron pieces, removing about ⅛ in. stock, at a table travel of 12 in. per minute. The cut is 7¼ in. wide and also includes the groove ⅝ in. wide by ⅛ in. deep, making a total of 12 cu. inches of metal removed per minute. The milled surfaces are flat and true

This job stands high above the table, but it goes through without any chatter, which is at once proof of the great rigidity of the table and the sufficiency of its bearings. It will stand up to this sort of work day after day. Isn't that the kind of a miller you want?

WE ARE MILLING SPECIALISTS.

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Canada Agent—H. W. Petrie, Limited, Toronto, Montreal and Vancouver.

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agement of Mr. E. C. Rutherford, of Toronto. A complete stock of thermit appliances will be carried at the Toronto office and works and the organization will be in a position to execute promptly the welding of heavy steel sections, such as crank shafts, locomotive frames, trolley rails, etc.

PRATT & WHITNEY CO., Hartford, Conn., announces that its Boston office now has a full line of small tools, cutters, reamers, arbors, taps, twist drills, etc., at its warehouse, 265 Atlantic Ave., and that orders sent to the Boston office will be filled and shipped at once. The company will also have on exhibit at the same place a sample line of its latest improved machinery for the equipment of tool-rooms and manufacturing plants. The address of the Boston office is Oliver Bldg., 141 Milk St.

THE Technical Publicity Association at its annual meeting April 30, 1908, elected the following officers to serve during the ensuing year: President, C. S. Redfield, advertising manager Yale & Towne Mfg. Co., New York; first vice-president, Rodman Gilder, publicity manager, Crocker-Wheeler Co., Ampere, N. J.; second vice-president, C. N. Manfred, manager advertising department, H. W. Johns-Manville Co., New York; secretary, H. H. Kress, publicity department, A. S. Cameron Steam Pump Works, New York; treasurer, H. M. Davis, advertising manager, Sprague Electric Co., New York. Members of the executive committee are F. H. Gale, charge of advertising General Electric Co., Schenectady, N. Y., and C. W. Beaver, special representative, Yale & Towne Mfg. Co., New York. Twenty new members have joined the association since the last annual meeting.

AMONG the most important international congresses to be held this year in Europe, is the Eighth International Congress for the Prevention of Accidents. Its sessions are held every three years, and are always attended by influential governmental officials, publicists, social economists, men of affairs, and professors. The reports of the congress are made by eminent world specialists, so that the volume of these proceedings is the record of the world's latest and best advance in accident prevention. Of especial value will be the report of an International Committee on the standardization, so to speak, of accidents, their causes, duration, and results, so that a world standard may be agreed upon as the basis for a comparative study. Membership in this congress is $2.00, which entitles the subscriber to all the reports and the complete proceedings. The membership fee may be sent to Dr. W. H. Tolman, 231 West 39th St., New York, by whom it will be acknowledged and forwarded to Rome.

COMING EVENTS.

June 9.—Convention, Air Brake Association, St. Paul, Minn. F. M. Nellis, 53 State St., Boston, Mass., secretary.

June 9 to 11.—Convention, American Foundrymen's Association, at Toronto, Canada. Richard Moldenke, Watchung, N. J., secretary.

June 17 to 19.—Master Car Builders' Association Convention, Atlantic City, N. J. Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill., secretary.

June 22 to 24.—American Railway Master Mechanics' Association Convention, Atlantic City, N. J. Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill., secretary.

June 23 to 26.—American Society of Mechanical Engineers, Annual Convention, Detroit, Mich. C. W. Rice, 29 W. 39th St., New York City, secretary.

June 23 to 27.—American Society for Testing Materials, Annual Meeting, Atlantic City, N. J. Edgar Marburg, University of Pennsylvania, Philadelphia, Pa., secretary.

June 23-26.—Society for the Promotion of Engineering Education, Annual Meeting, Detroit, Mich. A. L. Williston, Pratt Institute, Brooklyn, N. Y., secretary.

June 24 to 27.—Society for the Promotion of Engineering Education. Annual Convention, Detroit, Mich. Secretary, Prof. A. L. Williston, Pratt Institute, Brooklyn, N. Y.

June 24 to 27.—Engineering section of the Association of Licensed Automobile Manufacturers. Annual Convention, Detroit, Mich. Secretary, Coker Clarkson, 7 E. 42nd St., New York City.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

ADVERTISING MANAGER, aged 30, at present in charge of advertising department for a firm manufacturing machinery, open for a similar position. Well educated, mechanical training. Can compile technical copy. Familiar with details of catalogue publication; traveled over wide territory. Conversant with four languages. Competent to supervise the production of foreign as well as English matter. Address "W.," care MACHINERY, 49 Lafayette St., New York.

AN ENGLISH COMPANY having a plant suitable for the manufacture of small patented specialties in brass and steel, is prepared to negotiate for the manufacture of American patents—consequent upon the new patent laws now enforced in the British Isles. Works situated between Manchester and Liverpool. Address JOHN MACNAB, Engineer, Hyde, Cheshire, England.

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FILE OF "MACHINERY" FOR SALE.—Complete file of MACHINERY since 1898. Address "T. L.," care of The Industrial Press, 49-55 Lafayette St., New York City.

FORGE SUPERINTENDENT.—Tireless, practical man, is open for engagement; can produce results. Expert estimator, experienced in shape work in all branches. Steam forging, drop forging and modern methods of forging machinery. An able executive, 34 years of age. Location no objection. References. Looking for a position where push, low costs and ability are requisite factors. Box 175, care Industrial Press, New York.

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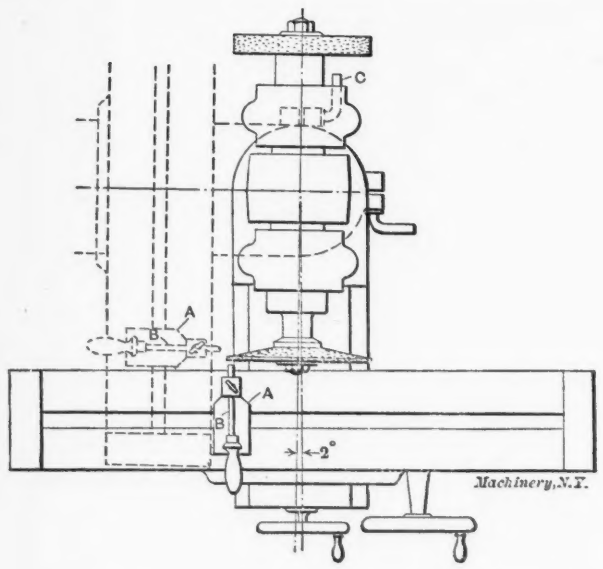
Supplement to MACHINERY, July, 1908.

Operations for the Article in this number entitled "Machine Shop Practice—Grinding a Gear-cutter."

SHOP OPERATION SHEET NO. 67.

Ethan Viall. MACHINERY, July, 1908.



Grinding a Gear-cutter—Truing the Emery Wheel.

1. Be sure that there is no play in the grinder spindle, that it runs freely and is well oiled; also see that the table ways are clean and free from grit and have oil enough so that the table can be moved easily.

2. Select a free-cutting saucer-shaped emery wheel about 6 inches in diameter, of medium grade and grain, and one that will not glaze or wear too fast.

3. Place the wheel, with the concave side out, on the end of the spindle which has a right-hand thread on it, which is the end that turns to the left when facing it.

4. Bolt the diamond holder *A* near the right-hand end of the table and clamp the diamond truing tool *B* in place.

5. Swing the knee around until the table is parallel with the spindle, and in the position indicated by the dotted lines. Adjust the table vertically until the diamond point is slightly below the center of the spindle, and then tighten the clamp *C*.

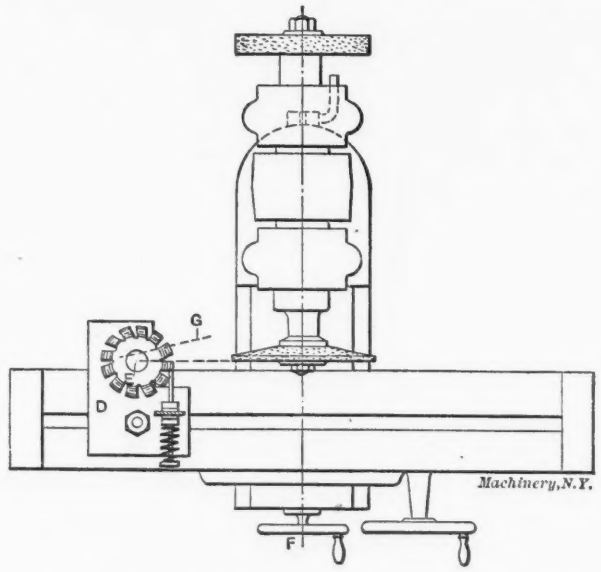
6. Start the grinder, and true up the wheel by feeding the diamond across its periphery.

7. Move the diamond truing tool and holder to the left end of the table. Loosen the clamp *C*, and swing the knee around until its center line makes an angle of 2 degrees with the axis of the spindle, as shown in the illustration, and again clamp the knee.

8. Bring the diamond truing tool into contact with the face of the wheel, and beginning at the edge, true at least a half-inch of its surface, and more if needed. Cut deep enough to remove all old glaze, and to true the wheel perfectly.

SHOP OPERATION SHEET NO. 68.

Ethan Viall. MACHINERY, July, 1908.



Grinding a Gear-cutter—Lining up Center of Cutter with Face of Wheel.

1. After truing the wheel as described in the previous operation sheet, carefully wipe off the table and clean out the slot.

2. Bolt a gear-cutter fixture *D* to the left end of the table, and place the cutter to be ground on the pin *E*, so that the teeth on that side of the cutter which is next to the wheel, will have their faces toward it. Loosen the table clamp and adjust the table vertically until the centers of the cutter teeth are the same height as the center of the grinder spindle.

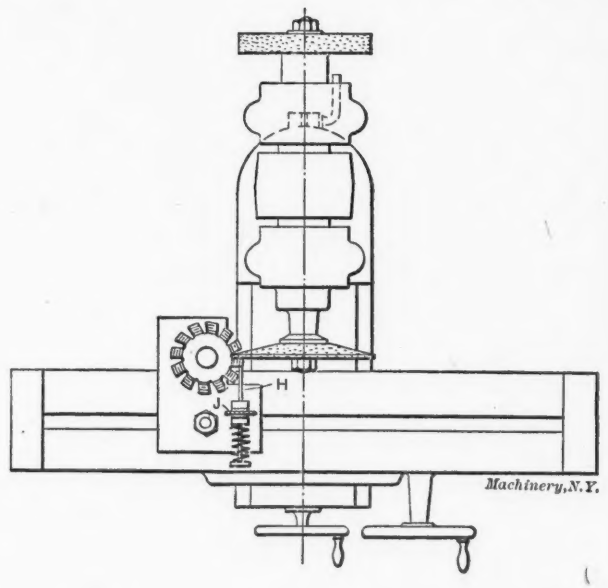
3. Carefully line up the table so that it is parallel with the face of the wheel. If there are no graduations on the machine for this purpose, set the table with the trued surface of the wheel, using a straight-edge.

4. With the jig and cutter far enough to the left to be clear of the wheel, lay a straight-edge across the face of the wheel and move the table out or in by means of the wheel *F* until the center of the pin *E* holding the gear-cutter is exactly in line with the outside face of the wheel. When the cutter is set in this way, the faces of the teeth will be radial or in line with the axis of the cutter.

NOTE.—It is important that the teeth of a gear-cutter be ground radially in order that the form of the teeth shall not be changed. If the top of a tooth is ground back faster than the base, and the face of the tooth be in the plane indicated by the line *G*, the shape of the tooth space cut is distorted, and a gear with badly shaped teeth is the result. In addition to this, the cutter works badly owing to the negative rake.

SHOP OPERATION SHEET NO. 69.

Ethan Viall. MACHINERY, July, 1908.



Grinding a Gear-cutter—Setting the Stop and Grinding.

NOTE.—It is assumed that the axis of the cutter is in line with the face of the emery wheel, and that the wheel has been trued.

1. Adjust the table longitudinally until the edge of the wheel rests against the bottom of one of the flutes between the teeth of the gear-cutter, and then tighten the table stop in the proper position to prevent the wheel from grinding the flute to a greater depth.

2. Turn the gear-cutter until a tooth rests lightly against the face of the wheel, then adjust the spring-stop *H* against the back of the tooth so that the cutter can be indexed freely, and also so that it will be held firmly against the wheel.

3. Move the cutter to the left until it is clear of the wheel and start the machine.

4. Carefully grind each tooth in turn, taking light cuts, then feed the teeth forward slightly by turning the knurled nut *J* which feeds the spring-stop *H*. Continue grinding until all cutting-edges are sharp and even.

NOTE.—When grinding cutters, light cuts must be taken to prevent the temper from being drawn from the cutting-edges, which would, of course, spoil the cutter. The face of the wheel which comes in contact with the work should be narrow, especially for dry cutter grinding, in order that the heat generated may be reduced to a minimum. If the cutter gets warm while grinding, remove it and cool in water. A moderately heavy and well-balanced wheel placed on the opposite end of the spindle will cause the grinder to run more steadily.

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IX.—TABLE OF IDEAL MOMENTS.

All values may be read in hundreds or thousands of inch pounds.

Bending Moments in Inch Pounds = M_b		Torsional Moments in Inch Pounds = M_t																		Bending Moment
		50	100	150	200	250	300	400	500	600	700	800	900	1000	1200	1400	1600	1800		
50	T	70.71	111.8	158.1	206.2	255.0	304.1	403.1	502.5	602.1	2119	2154	2193.	2236	2332	2441	2561	2691		2000
	B	120.7	161.8	208.1	256.2	305.0	354.1	453.1	552.5	652.1	4119	4154	4193	4236	4332	4441	4561	4691		
75	T	90.14	125.0	167.7	213.6	261.0	309.2	407.0	505.6	604.7	704.0	803.5	2577	2417	2506	2608	2720	2845		2200
	B	165.1	200.0	242.7	288.6	336.0	384.2	482.0	580.6	679.7	779.0	878.5	4577	4617	4706	4808	4920	5043		
100	T	111.8	141.4	180.3	223.6	269.3	316.2	412.3	509.9	608.3	707.1	806.2	2563	2600	2683	2778	2884	3000		2400
	B	211.8	241.4	280.3	323.6	369.3	416.2	512.3	609.9	708.3	807.1	906.2	4963	5000	5083	5178	5284	5400		
125	T	134.6	160.1	195.3	235.9	279.5	325.0	419.1	515.4	612.9	711.1	809.7	908.6	2786	2864	2953	3053	3162		2600
	B	259.6	285.1	320.3	360.9	404.5	450.0	544.1	640.4	737.9	836.1	934.7	1034	5386	5464	5553	5653	5762		
150	T	158.1	180.3	212.1	250.0	291.5	335.4	427.2	522.0	618.5	715.9	813.9	912.4	2973	3046	3131	3225	3329		2800
	B	308.1	330.3	362.1	400.0	441.5	485.4	577.2	672.0	768.5	865.9	963.9	1062	5773	5846	5931	6025	6129		
200	T	206.2	223.6	250.0	282.8	320.2	360.6	447.2	538.5	632.5	728.0	824.6	922.0	1020	3231	3311	3400	3499		3000
	B	406.2	423.6	450.0	482.8	520.2	560.6	647.2	738.5	832.5	928.0	1025	1122	1220	6231	6311	6400	6499		
250	T	255.0	269.3	291.5	320.2	353.6	390.5	471.1	559.0	650.0	743.3	838.2	934.1	1031	1226	3770	3848	3936		3500
	B	505.0	519.3	541.5	570.2	603.6	640.5	721.7	809.0	900.0	993.3	1088	1184	1281	1476	7210	7348	7436		
300	T	304.2	316.2	335.4	360.6	390.5	424.3	500.0	583.1	670.8	761.6	854.4	948.7	1044	1237	1432	4308	4380		4000
	B	604.2	616.2	635.4	660.6	690.5	724.3	800.0	883.1	970.8	1062	1154	1249	1344	1537	1732	8308	8380		
350	T	353.6	364.0	380.8	403.1	430.1	461.0	531.5	610.3	694.6	782.6	873.2	965.7	1059	1250	1445	1638	4847		4500
	B	703.6	714.0	730.8	753.1	780.1	811.0	881.5	960.3	1045	1133	1223	1316	1409	1600	1793	1988	9347		
400	T	403.1	412.3	427.2	447.2	471.7	500.0	565.7	640.3	721.1	806.2	894.4	984.9	1077	1265	1456	1649	1844		400
	B	803.1	812.3	827.2	847.2	871.7	900.0	965.7	1040	1121	1206	1294	1385	1477	1665	1856	2049	2244		
450	T	452.8	461.0	474.3	492.4	514.8	540.8	602.1	672.7	750.0	832.2	917.9	1006	1097	1282	1471	1662	1855		450
	B	902.8	911.0	924.3	942.4	964.8	990.8	1052	1123	1200	1282	1368	1456	1547	1732	1921	2112	2305		
500	T			522.0	538.5	559.0	583.1	640.3	707.1	781.0	860.2	943.4	1030	1118	1300	1487	1676	1868		500
	B			1022	1039	1059	1083	1140	1207	1281	1360	1443	1530	1618	1800	1987	2176	2368		
600	T			618.5	632.5	650.0	670.8	721.1	781.0	848.5	922.0	1000	1082	1166	1342	1523	1709	1897		600
	B			1219	1233	1250	1271	1321	1381	1449	1522	1600	1682	1766	1942	2123	2309	2497		
700	T				728.0	743.3	761.6	806.2	860.2	922.0	990.0	1063	1140	1221	1389	1565	1746	1931		700
	B				1428	1443	1462	1506	1560	1622	1690	1763	1840	1921	2089	2265	2446	2631		
800	T				824.0	838.2	854.4	894.4	943.3	1000	1063	1131	1204	1281	1442	1612	1789	1970		800
	B				1625	1638	1654	1694	1743	1800	1863	1931	2004	2081	2242	2412	2589	2770		
900	T					934.1	948.7	984.9	1030	1082	1140	1204	1273	1345	1500	1664	1836	2012		900
	B					1834	1849	1885	1930	1982	2040	2104	2173	2245	2400	2564	2736	2912		
1000	T					1031	1044	1077	1118	1166	1221	1281	1345	1414	1562	1720	1887	2059		1000
	B					2031	2044	2077	2118	2166	2221	2281	2345	2414	2562	2720	2887	3059		
1100	T						1140	1170	1208	1253	1304	1360	1421	1487	1628	1780	1942	2110		1100
	B						2240	2270	2308	2353	2404	2460	2521	2587	2728	2880	3042	3210		
1200	T						1237	1265	1300	1342	1389	1442	1500	1562	1697	1844	2000	2163		1200
	B						2437	2465	2500	2542	2589	2642	2700	2762	2897	3044	3200	3363		
1400	T							1456	1487	1523	1565	1612	1664	1720	1844	1980	2126	2280		1400
	B							2356	2387	2423	2465	3012	3064	3120	3244	3380	3526	3680		
1600	T							1649	1676	1709	1746	1789	1836	1887	2000	2126	2263	2608		1600
	B							3249	3276	3309	3346	3389	3436	3487	3600	3726	3863	4208		
1800	T								1868	1897	1931	1970	2012	2059	2163	2280	2408	2546		1800
	B								3668	3697	3731	3770	3812	3859	3963	4080	4208	4346		

M_t = Torsional Moment
M_b = Bending Moment
T = Ideal Torsional Moment
B = Ideal Bending Moment

$T = \sqrt{M_t^2 + M_b^2}$ and $B = M_b + \sqrt{M_t^2 + M_b^2}$

These ideal moments being for use with the Polar Section Modulus.

The values at right of heavy zig-zag line across upper right-hand corner are for the bending moments 2,000 to 4,500, inclusive, in right-hand column.

Contributed by John S. Myers.

X.—TABLE OF IDEAL MOMENTS.

Bending Moments in Inch Pounds = M_b		Torsional Moments in Inch Pounds = M_t																		
		2000	2200	2400	2800	3200	3600	4000	4400	4800	5200	5600	6000	7000	8000	9000	10000	11000	12000	
600	T	2088	2280	2474	2864	3256	3650	4045	4441	4837	5235	5632	6030	7026	8023	9020	10018	11016	12015	
	B	2688	2880	3074	3464	3856	4250	4645	5041	5437	5835	6232	6630	7626	8623	9620	10618	11616	12615	
700	T	2119	2301	2500	2886	3276	3667	4061	4455	4851	5247	5644	6041	7035	8031	9027	10025	11022	12020	
	B	2819	3001	3200	3586	3976	4367	4761	5155	5551	5947	6344	6741	7735	8731	9727	10725	11722	12720	
800	T	2154	2341	2530	2912	3298	3688	4076	4472	4866	5261	5657	6053	7046	8040	9035	10032	11029	12027	
	B	2954	3141	3330	3712	4098	4488	4876	5272	5666	6061	6457	6853	7846	8840	9835	10832	11829	12827	
900	T	2193	2377	2563	2941	3324	3711	4100	4491	4884	5277	5672	6067	7058	8051	9045	10040	11037	12034	
	B	3093	3277	3463	3841	4224	4611	5000	5391	5784	6177	6572	6967	7958	8951	9945	10940	11937	12934	
1000	T	2236	2419	2600	2973	3353	3736	4123	4512	4903	5295	5689	6083	7071	8062	9055	10050	11045	12042	
	B	3236	3419	3600	3973	4353	4736	5123	5512	5903	6295	6689	7083	8071	9062	10055	11050	12045	13042	
1100	T	2283	2460	2640	3008	3384	3764	4149	4535	4924	5315	5707	6100	7086	8075	9067	10060	11055	12050	
	B	3383	3560	3740	4108	4484	4864	5249	5635	6024	5415	6807	7100	8186	9175	10167	11160	12155	13150	
1200	T	2332	2506	2683	3046	3418	3795	4176	4561	4948	5337	5764	6119	7102	8090	9080	10072	11065	12060	
	B	3532	3706	3883	4246	4618	4995	5376	5761	6148	6537	6964	7319	8302	9290	10280	11272	12265	13260	
1400	T	2441	2608	2778	3131	3493	3863	4238	4617	5000	5385	5772	6161	7139	8122	9108	10097	11089	12081	
	B	3841	4008	4178	4531	4893	5263	5638	6017	6400	6785	7172	7561	8539	9522	10580	11497	12489	13481	
1600	T	2561	2720	2884	3225	3578	3940	4308	4682	5060	5441	5824	6210	7181	8158	9141	10127	11116	12106	
	B	4161	4320	4484	4825	5178	5540	5908	6282	6660	7041	7424	7810	8781	9758	10741	11727	12716	13706	
1800	T	2691	2843	3000	3329	3672	4025	4386	4754	5126	5503	5882	6264	7228	8200	9178	10161	11146	12134	
	B	4491	4643	4800	5129	5472	5825	6186	6554	6926	7303	7682	8064	9028	10000	10978	11961	12946	13934	
2000	T	2828	2973	3124	3441	3774	4119	4472	4837	5200	5571	5946	6325	7141	8246	9220	10198	11180	12166	
	B	4828	4973	5124	5441	5774	6119	6472	6837	7200	7571	7946	8325	9141	10246	11220	12198	13180	14166	
2200	T	2973	3111	3256	3561	3883	4219	4565	4919	5280	5646	6019	6391	7338	8297	9265	10239	11218	12200	
	B	5173	5311	5456	5761	6083	6419	6765	7119	7480	7846	8219	8591	9538	10497	11465	12439	13418	14400	
2400	T	3124	3256	3394	3688	4000	4327	4665	5012	5367	5727	6093	6462	7400	8352	9315	10284	11259	12238	
	B	5524	5656	5794	6088	6400	6727	7065	7412	7767	8127	8493	8862	9800	10752	11715	12684	13659	14638	
2600	T	3280	3406	3538	3821	4123	4441	4771	5111	5459	5814	6174	6532	7467	8412	9368	10333	11303	12278	
	B	5880	6006	6138	6421	6723	7041	7371	7711	8059	8414	8774	9132	10067	11012	11968	12933	13903	14878	
2800	T	3441	3561	3688	3960	4252	4561	4883	5216	5557	5906	6261	6621	7533	8476	9426	10385	11351	12322	
	B	6241	6361	6488	6760	7052	7361	7683	8016	8357	8706	9061	9421	10333	11276	12226	13185	14151	15122	
3000	T	3601	3720	3842	4104	4386	4686	5000	5325	5660	6003	6353	6708	7616	8544	9487	10440	11402	12369	
	B	6601	6720	6842	7104	7386	7686	8000	8325	8660	9003	9353	9708	10616	11544	12487	13440	14402	15369	
3500	T	4031	4134	4244	4482	4742	5021	5315	5622	5941	6268	6604	6946	7826	8732	9657	10609	11543	12500	
	B	7531	7634	7744	7982	8242	8521	8815	9122	9441	9768	10104	10446	11326	12232	13157	14109	15045	16000	
4000	T	4472	4565	4665	4883	5123	5381	5657	5946	6248	6561	6882	7211	8062	8944	9849	10770	11705	12649	
	B	8472	8565	8665	8883	9123	9381	9657	9946	10248	10561	10882	11211	12062	12944	13849	14770	15705	16649	
4500	T	4924	5009	5100	5300	5522	5763	6021	6294	6580	6877	7184	7500	8322	9179	10062	10966	11885	12816	
	B	9424	9509	9600	9800	10022	10263	10521	10794	11080	11377	11684	12000	12822	13679	14562	15466	16385	17316	
5000	T	5385	5463	5546	5731	5936	6161	6403	6660	6931	7214	7507	7810	8602	9434	10296	11180	12083	13000	
	B	10385	10463	10546	10731	10936	11161	11403	11660	11931	12214	12507	12810	13602	14434	15296	16180	17083	18000	
5500	T	5852	5924	6001	6172	6363	6573	6801	7043	7300	7569	7849	8139	8902	9708	10548	11413	12298	13200	
	B	11352	11424	11501	11672	11863	12073	12301	12543	12800	13069	13349	13639	14402	15208	16048	16913	17798	18700	
6000	T	6325	6391	6462	6621	6800	6987	7211	7440	7684	7940	8207	8485	9220	10000	10817	11662	12530	13416	
	B	12325	12391	12462	12621	12800	12987	13211	13440	13684	13940	14207	14485	15220	16000	16817	17662	18530	19416	

Contributed by John S. Myers.

XI.—DIAMETERS OF SHAFTS FOR COMBINED TORSION AND BENDING STRESSES.

Fiber Stress in Pounds per square inch			Torsional Moments in Thousands of Inch Pounds.																			Fiber Stress in Pounds per square inch		
7500			0	3.75	7.5	11.25	15	18.75	22.5	30	37.5	45	52.5	60	67.5	75	90	105	120	135				7500
	10000		0	5	10	15	20	25	30	40	50	60	70	80	90	100	120	140	160	180			10000	
		12500	0	6.25	12.5	18.75	25	31.25	37.5	50	62.5	75	87.5	100	112.5	125	150	175	200	225	12500			
0	0	0	0	1 3/8	1 23/32	1 31/32	2 3/16	2 11/32	2 1/2	2 3/4	2 15/16	3 1/8	3 9/16	3 7/16	3 19/32	3 23/32	3 15/16	4 5/32	4 11/32	4 1/2	0	0	0
3.75	5	6.25	1 23/32	1 27/32	2 1/32	2 7/32	2 3/8	2 1/2	2 5/8	2 27/32	3 1/16	3 7/32	5 15/16	5 31/32	5 31/32	6	6 1/16	6 1/16	6 1/8	6 3/16	250	200	150
5.625	7.5	9.375	1 31/32	2 1/32	2 3/16	2 5/16	2 15/32	2 19/32	2 11/16	2 29/32	3 3/32	3 1/4	3 13/32	3 9/16	0 3/16	0 3/16	6 1/4	6 1/4	6 5/16	6 3/8	275	220	165
7.5	10	12.5	2 3/16	2 7/32	2 5/16	2 7/16	2 9/16	2 21/32	2 25/32	2 31/32	3 5/32	3 5/16	3 7/16	3 19/32	0 5/16	6 3/8	6 3/8	6 7/16	6 7/16	6 1/2	300	240	180
9.375	12.5	15.63	2 11/32	2 3/8	2 7/16	2 17/32	2 21/32	2 3/4	2 27/32	3 1/32	3 3/16	3 11/16	3 1/2	3 5/8	3 3/4	6 1/2	6 9/16	6 9/16	6 5/8	6 5/8	325	260	195
11.25	15	18.75	2 1/2	2 1/2	2 9/16	2 31/32	2 3/4	2 13/16	2 29/32	3 3/32	3 1/4	3 13/32	3 17/32	3 21/32	3 25/32	6 5/8	6 11/16	6 11/16	6 3/4	6 13/16	350	280	210
15	20	25	2 3/4	2 3/4	2 25/32	2 27/32	2 29/32	3	3 1/16	3 7/32	3 11/32	3 1/2	3 5/8	3 3/4	3 27/32	3 31/32	6 13/16	6 7/8	6 7/8	6 15/16	375	300	225
18.75	25	31.25	2 15/16	2 15/16	2 31/32	3 1/32	3 3/32	3 1/8	3 3/16	3 11/32	3 15/32	3 19/32	3 23/32	3 13/16	3 15/16	4 1/32	4 1/32	7 3/16	7 3/16	7 1/4	437.5	350	262.5
22.5	30	37.5	3 1/8	3 5/32	3 5/32	3 3/16	3 1/4	3 9/32	3 11/32	3 7/16	3 9/16	3 11/16	3 25/32	3 1/8	4	4 3/32	4 9/32	4 15/32	7 1/2	7 1/2	500	400	300
26.25	35	43.75	3 9/32	3 9/32	3 5/16	3 11/32	3 3/8	3 13/32	3 15/32	3 9/16	3 21/32	3 3/4	3 1/8	3 31/32	4 1/16	4 5/32	4 11/32	4 1/2	4 21/32	7 13/16	562.5	450	337.5
30	40	50	3 7/16			3 15/32	3 1/2	3 17/32	3 19/32	3 21/32	3 3/4	3 27/32	3 15/16	4 1/16	4 1/8	4 7/32	4 13/32	4 9/16	4 23/32	4 27/32	50	40	30
33.75	45	56.25	3 19/32				3 5/8	3 21/32	3 11/16	3 25/32	3 27/32	3 15/16	4 1/32	4 1/8	4 7/32	4 9/32	4 7/16	4 5/8	4 3/4	4 29/32	56.25	45	33.75
37.5	50	62.5	3 23/32				3 3/4	3 25/32	3 13/16	3 7/8	3 15/16	4 1/32	4 1/8	4 3/16	4 9/32	4 11/32	4 1/2	4 21/32	4 13/16	4 15/16	62.5	50	37.5
45	60	75	3 15/16				3 31/32	4	4 1/32	4 1/16	4 1/8	4 3/16	4 9/32	4 11/32	4 13/32	4 1/2	4 5/8	4 25/32	4 29/32	5 1/32	75	60	45
52.5	70	87.5	4 5/32				4 3/16	4 7/16	4 7/32	4 1/4	4 5/16	4 3/8	4 13/32	4 15/32	4 17/32	4 5/8	4 3/4	4 7/8	5	5 1/8	87.5	70	52.5
60	80	100	4 11/32					4 3/8	4 3/8	4 13/32	4 15/32	4 1/2	4 17/32	4 19/32	4 21/32	4 3/4	4 27/32	4 31/32	5 3/32	5 7/32	100	80	60
67.5	90	112.5	4 1/2					4 11/32	4 19/32	4 5/8	4 21/32	4 25/32	4 13/16	4 7/8	4 31/32	5 1/16	5 3/16	5 5/16	112.5	90	67.5			
75	100	125	4 11/16					4 23/32	4 25/32	4 3/4	4 25/32	4 13/16	4 7/8	4 15/16	5 1/32	5 3/16	5 9/16	5 3/8	125	100	75			
82.5	110	137.5	4 13/16					4 27/32	4 7/8	4 29/32	4 15/16	5	5 1/32	5 3/32	5 3/16	5 9/32	5 3/8	5 15/32	137.5	110	82.5			
90	120	150	4 31/32						5	5 1/32	5 1/16	5 3/32	5 1/8	5 5/32	5 7/32	5 9/32	5 3/8	5 15/32	5 9/16	150	120	90			
105	140	175	5 7/32						5 1/4	5 9/32	5 5/16	5 11/32	5 11/32	5 3/8	5 7/16	5 1/2	5 9/16	5 21/32	5 23/32	175	140	105			
120	160	200	5 15/32							5 1/2	5 17/32	5 17/32	5 9/16	5 19/32	5 5/8	5 11/16	5 3/4	5 13/16	6	200	160	120			
135	180	225	5 11/16							5 23/32	5 3/4	5 3/4	5 25/32	5 25/32	5 13/16	5 7/8	5 15/16	6	6 1/16	225	180	135			

Bending Moments in Thousands of Inch Pounds.

Values at right of heavy zig-zag line across upper right-hand corner are for the bending moments in upper part of three right-hand columns.

Contributed by John S. Myers.

XII.—DIAMETERS OF SHAFTS FOR COMBINED TORSION AND BENDING STRESSES.

Fiber Stress in Pounds per square inch			Torsional Moments in Thousands of Inch Pounds.																		
7500			0	150	165	180	210	240	270	300	330	360	390	420	450	525	600	675	750	825	900
	10000		0	200	220	240	280	320	360	400	440	480	520	560	600	700	800	900	1000	1100	1200
		12500	0	250	275	300	350	400	450	500	550	600	650	700	750	875	1000	1125	1250	1375	1500
0	0	0	0	4 11/16	4 13/16	4 31/32	5 7/32	5 15/32	5 11/16	5 7/8	6 1/16	6 1/4	6 7/16	6 9/16	6 3/4	7 1/16	7 7/16	7 11/16	8	8 1/4	8 1/2
45	60	75	3 15/16	5 5/32	5 9/32	5 3/8	5 19/32	5 13/16	6	6 3/16	6 3/8	6 1/2	6 11/16	6 13/16	6 15/16	7 5/16	7 5/8	7 7/8	8 1/8	8 3/8	8 5/8
52.5	70	87.5	4 5/32	5 1/4	5 11/32	5 15/32	5 11/16	5 7/8	6 1/16	6 1/4	6 7/16	6 9/16	6 3/4	6 7/8	7	7 5/16	7 5/8	7 15/16	8 3/16	8 7/16	8 5/8
60	80	100	4 11/32	5 5/16	5 7/16	5 17/32	5 3/4	5 15/16	6 1/8	6 5/16	6 7/16	6 5/8	6 3/4	6 7/8	7 1/16	7 5/8	7 11/16	7 15/16	8 3/16	8 7/16	8 11/16
67.5	90	112.5	4 1/2	5 13/32	5 1/2	5 5/8	5 13/16	6	6 3/16	6 5/16	6 1/2	6 5/8	6 13/16	6 15/16	7 1/16	7 3/8	7 11/16	8	8 1/4	8 1/2	8 11/16
75	100	125	4 11/16	5 15/32	5 19/32	5 11/16	5 7/8	6 1/16	6 1/4	6 3/8	6 9/16	6 11/16	6 7/8	7	7 1/8	7 7/16	7 3/4	8	8 1/4	8 1/2	8 3/4
82.5	110	137.5	4 13/16	5 9/16	5 21/32	5 3/4	5 15/16	6 1/8	6 5/16	6 7/16	6 5/8	6 3/4	6 7/8	7	7 1/8	7 1/2	7 3/4	8 1/16	8 5/16	8 1/2	8 3/4
90	120	150	4 31/32	5 21/32	5 3/4	5 27/32	6	6 3/16	6 3/8	6 1/2	6 5/8	6 3/4	6 15/16	7 1/16	7 3/16	7 1/2	7 13/16	8 1/16	8 5/16	8 9/16	8 3/4
105	140	175	5 7/32	5 15/16	5 7/8	5 31/32	6 1/8	6 5/16	6 7/16	6 5/8	6 3/4	6 7/8	7	7 1/8	7 1/4	7 9/16	7 7/8	8 1/8	8 3/8	8 5/8	8 13/16
120	160	200	5 15/32	5 31/32	6 1/16	6 1/8	6 5/16	6 7/16	6 9/16	6 11/16	6 7/8	7	7 1/8	7 1/4	7 3/8	7 5/8	7 15/16	8 3/16	8 7/16	8 11/16	8 7/8
135	180	225	5 11/16	6 1/8	6 3/16	6 1/4	6 3/8	6 9/16	6 11/16	6 13/16	6 15/16	7 1/16	7 3/16	7 5/16	7 7/16	7 11/16	8	8 1/4	8 1/2	8 11/16	8 15/16
150	200	250	5 7/8	6 1/4	6 5/16	6 3/8	6 1/2	6 5/8	6 13/16	6 15/16	7 1/16	7 3/16	7 1/4	7 3/8	7 1/2	7 3/4	8 1/16	8 5/16	8 9/16	8 3/4	8 15/16
165	220	275	6 1/16	6 7/16	6 1/2	6 9/16	6 5/8	6 3/4	6 15/16	7	7 1/8	7 1/4	7 3/8	7 1/2	7 9/16	7 7/8	8 1/8	8 3/8	8 9/16	8 13/16	9
180	240	300	6 1/4	6 9/16	6 5/8	6 11/16	6 3/4	6 7/8	7	7 1/8	7 1/4	7 5/16	7 7/16	7 9/16	7 11/16	7 15/16	8 5/16	8 7/16	8 5/8	8 7/8	9 1/16
195	260	325	6 7/16	6 11/16	6 3/4	6 13/16	6 7/8	7	7 1/8	7 5/16	7 5/16	7 7/16	7 9/16	7 5/8	7 3/4	8	8 1/4	8 1/2	8 11/16	8 15/16	9 1/8
210	280	350	6 9/16	6 13/16	6 7/8	6 15/16	7	7 1/8	7 3/16	7 5/16	7 7/16	7 1/2	7 5/8	7 3/4	7 13/16	8 1/16	8 5/16	8 9/16	8 3/4	8 15/16	9 3/16
225	300	375	6 3/4	6 15/16	7	7 1/16	7 1/8	7 1/4	7 3/8	7 7/16	7 1/2	7 5/8	7 11/16	7 13/16	7 15/16	8 1/8	8 3/8	8 5/8	8 13/16	9	9 1/4
262.5	350	437.5	7 1/16	7 1/4	7 5/16	7 3/8	7 7/16	7 1/2	7 9/16	7 5/8	7 3/4	7 13/16	7 15/16	8	8 1/8	8 5/16	8 9/16	8 3/4	8 15/16	9 1/8	9 3/8
300	400	500	7 7/16	7 9/16	7 9/16	7 5/8	7 11/16	7 3/4	7 13/16	7 7/8	8	8 1/16	8 1/8	8 3/16	8 5/16	8 1/2	8 11/16	8 7/8	9 1/8	9 5/16	9 7/16
337.5	450	562.5	7 11/16	7 13/16	7 7/8	7 7/8	7 15/16	8	8 1/16	8 1/8	8 3/16	8 1/4	8 5/16	8 7/16	8 1/2	8 11/16	8 7/8	9 1/16	9 1/4	9 7/16	9 5/8
375	500	625	8	8 1/16	8 1/8	8 1/8	8 3/16	8 1/4	8 5/16	8 3/8	8 7/16	8 1/2	8 9/16	8 5/8	8 11/16	8 7/8	9	9 3/16	9 3/8	9 9/16	9 3/4
412.5	550	687.5	8 1/4	8 5/16	8 3/8	8 3/8	8 7/16	8 1/16	8 1/2	8 9/16	8 5/8	8 11/16	8 3/4	8 13/16	8 7/8	9	9 3/16	9 3/8	9 1/2	9 11/16	9 7/8
450	600	750	8 1/2	8 9/16	8 9/16	8 5/8	8 5/8	8 11/16	8 3/4	8 3/4	8 13/16	8 7/8	8 15/16	9	9 1/16	9 3/16	9 3/8	9 1/2	9 5/8	9 13/16	10

Bending Moments in Thousands of Inch Pounds.

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